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FRAGER'S WATER METER.

In 1872, M. Frager introduced to the notice of water-supply companies a new water meter, which was very favorably received, and which from that time to the present has been extensively used by the companies supplying water to various of the larger towns and cities of France. Recently the inventor has greatly modified the construction of the apparatus, so that it is exceedingly simple, moderate in price, and is not influenced in its correct working by variations in pressure. The operation of this meter, which is shown in the annexed cuts, is as follows:

The water enters the meter through the inlet pipe, which empties at the top of the distributing box. It traverses a sieve, which serves to remove the larger impurities, and exerts its pressure against the slide valves, T and T'. This pressure is transmitted to the measuring cylinders, C_1 and C_4, from the cylinders, C_2 and C_3, through the orifices, O_1 and O_4, which stand open. Since, at the same instant, the orifices, O_2 and O_3, are in communication with the outlet pipe through the intermedium of the ports of the slide valves which cover them, the spaces, C_2 and C_3, are in a state of discharge, and the pistons, P and P', which separate these chambers from the first, tend to displace themselves toward the left. The piston, P', abutting against the end to the left, by the extremity of its rod, remains immovable; but P moves forward toward this same end, and, striking against it, admits a cylinderful of water into C_1, at the same time expelling a like quantity of water from C_2. Before reaching the limit of its travel, it displaces the slide valve, T', which uncovers the orifice, O_2, and covers up the orifice, O_1. As a consequence of these displacements the pressures are reversed in the cylinder, C_1; C_2 is charged; C_4 is discharged; and the piston, P, shoved toward the right end, drives a second cylinderful of water into the discharge pipe. Before stopping at the end of its travel, it displaces the slide valve, T', which uncovers O_3 and covers O_1. Owing to this displacement, the pressures are reversed in the cylinder, C_1, and C_3 is charged, while C_1 is emptied. The piston, P, moves toward the right, driving a third cylinderful of water into the discharge pipe, displacing, on arrival at the end of its travel, the valve, T, and thus causing the expulsion of a fourth cylinderful of water by the piston, P'.

The different parts of the mechanism have now returned to their starting point, except the ratchet-wheel, R, which has moved forward but one tooth, while the apparatus has been distributing the four cylinderfuls of water. This ratchet-wheel actuates the clockwork which registers the quantity of water that passes through the meter. The movements just described take place as long as the inlet cock remains open.

It only remains to add a few complementary details.

Each piston, toward the end of its travel, actuates the valve which distributes the water into the other cylinder. To effect this the piston rod carries two cams, H_1 and H_2, or H_3 and H_4, which alternately act on the friction roller at the lower extremity of the controlling lever, L or L'; the latter moving on the axle, A or A'. The eccentric head of this axle is situated under the port of the slide valve (in a compartment separated from the one which operates to distribute the water) in such a manner that it pushes along the valve and carries it around the axle, now over the right orifice and then over the left one. The mechanism which transmits motion to the clockwork is also very simple. The lever, L, carries a pawl, Q, moving about a vertical axle. When the lever is placed toward the left, the pawl engages with the ratchet, R, and causes it to move forward one tooth in pivoting itself around its own axis. When the lever turns backward the catch of the pawl becomes disengaged, and is carried back to its starting point by the action of the center of the ratchet-wheel on the tail of the pawl. The ratchet-wheel itself moves the clockwork by means of an axle, which, after passing through a stuffing-box, enters the clockwork case. Finally, the meter is provided with an ingenious arrangement which allows the fact to be ascertained at any moment as to whether the apparatus is water-tight. To effect this object, the cams, H_2 and H_4, of the

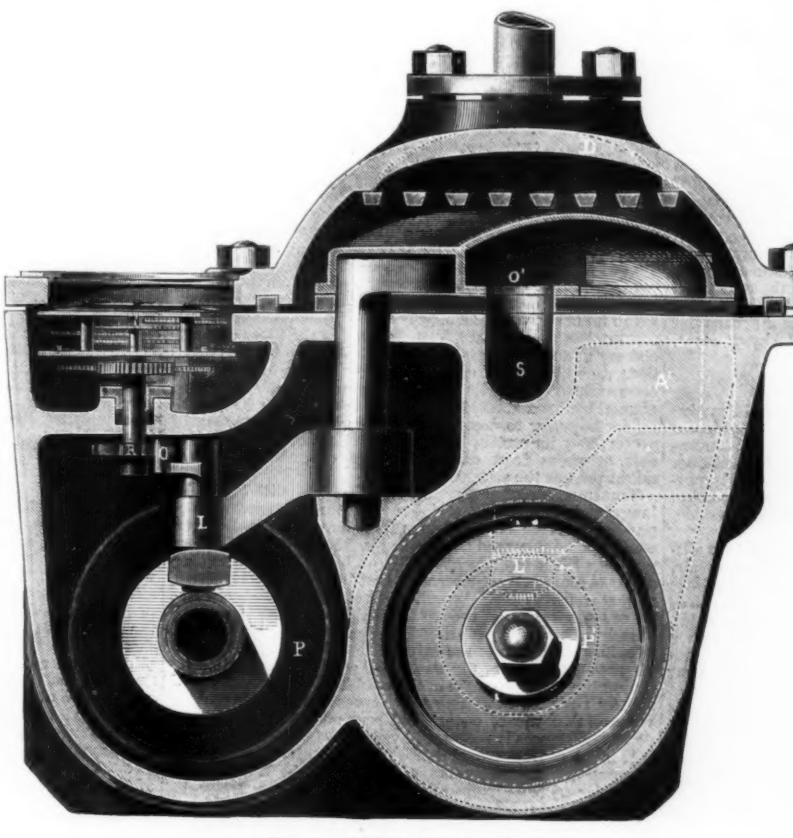


Fig. 1.—VERTICAL SECTION.

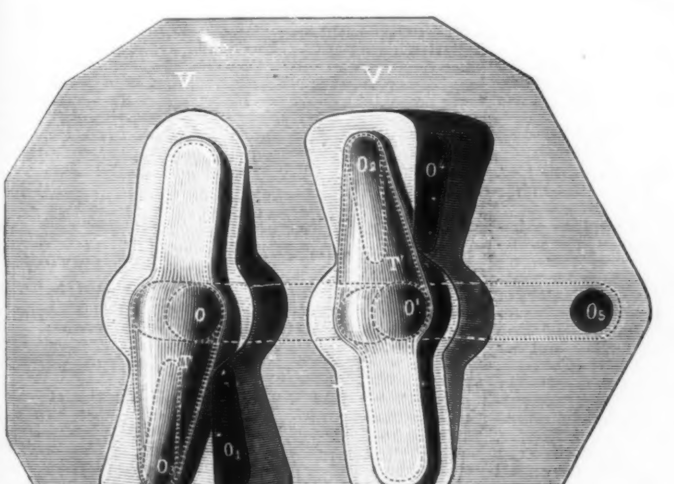


Fig. 2.—PLAN OF THE APPARATUS.—THE DOME REMOVED TO SHOW DISTRIBUTION.

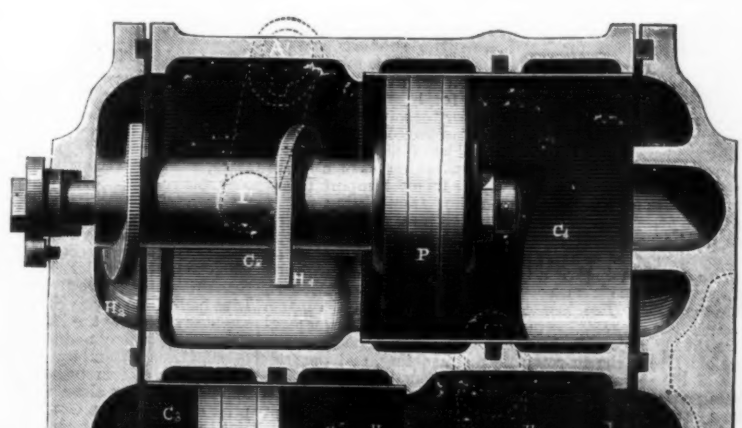


Fig. 3.—HORIZONTAL SECTION THROUGH THE AXIS OF THE PISTONS.

FRAGER'S WATER METER.

piston, P′, are made helicoidal in shape, so that if the piston-rod (and consequently the cams) be revolved about half a turn to the left, the cam, H_2, in consequence of its peculiar shape, is thrown out of the way and no longer engages the lever, L′, to a sufficient degree to displace the slide valve, T. The piston, P, will then remain pressed close up against the left end of the cylinder, and the piston, P′, against the right end. The meter will thus stop working, and the flow of water will cease entirely if there be no leak. To set the meter in operation again, it is only necessary to move the stoppage eccentric back to its first position, when the helicoidal flange of the cam, H_2, acting on the lever, L′, and displacing the slide valve, T, will put the apparatus in motion. If, after bringing back the stoppage eccentric to its proper position, it be immediately turned to the left, the apparatus begins operating and stops anew after distributing four cylinderfuls. It is easy then to ascertain: (1) Whether the meter has any leaks; and (2) whether the capacity of the four measuring cylinders is in proper accordance with the clockwork.

The apparatus is easily taken apart and put together again, and, as regards construction, is exceedingly strong. With the exception of the piston packing (which is rubber), all the parts are of metal. There is hardly any need of speaking of the applications which may be made of the water meter. But there is one, however, which we consider proper to dwell on, since it offers to manufacturers a means of controlling the operations of their generators and engines. We refer to the measurement of the feed-water.

By a special arrangement, the meter may be placed on the supply pipe of the feed-pump. There is a safety valve provided for the prevention of accidents, and a check valve for preventing back-flow from the boiler. From the very construction of the apparatus, it is able to work equally well with either hot or cold water. The exact knowledge of the quantity of water vaporized by the boiler allows, by comparison with the weight of coal consumed during the same time, of ascertaining with the greatest certainty the cost per pound of steam, and of determining the choice of coal. Besides this, if the revolutions of the driving shaft of the engine be counted, the expense of steam per revolution of the fly-wheel may be estimated; and thus the movements of the engine can be regulated so as to prevent that increase in the consumption of fuel which follows an excess of speed. The use of the water meter and of the revolution counter results then in a considerable reduction in the expense of fuel, while at the same time it allows the behavior of the boilers and engine to be ascertained at any moment.

TRANSMISSION OF POWER.

When machinery is situated at a distance from the motive force, or when the power has to be distributed to different parts, it is necessary to adopt some other means of transmitting the power than that furnished by ordinary shafting. The most common and best means employed for this purpose for short distances are belts of leather or gutta percha; but when the strain is great and the distance is considerable, other arrangements have to be resorted to.

Four different methods of transmitting power to a distance have been used, namely, wire ropes, compressed air, water pressure, and electricity. The first of these methods is merely an extension of the ordinary system of belts, so as to be suitable for considerable strains and for transmission to a distance. This plan of wire ropes has been tried on a large scale, to transmit the power produced by turbines worked by large natural falls of water, at Oberursel, near Frankfort-on-the-Main, at Schaffhausen, at Bellegarde, and at Fribourg on the Saane, a branch of the Aar. The factories established there have not proved particularly successful, in spite of the economy of the motive power; but this must be attributed to their unfortunate situation, and not to any defect in the method of transmitting the power. The want of flexibility in the wire ropes was provided for by the employment of large pulleys, which were made as much as 17½ feet in diameter at Bellegarde. The advantage of this system is that it furnishes a high rate of efficiency, as the loss by transmission with a single rope has been estimated to amount to only six per cent. When, however, the distance to be traversed is considerable, relays have to be provided, as the interval between the pulleys is generally made between 400 feet and 500 feet, and each relay produces a reduction of the effective force. Though this system would not appear to be particularly suitable on very rough ground, or where the differences of level are considerable, a height of 269 feet was surmounted at Fribourg; and inequalities of level are provided for by intermediate supports, and by placing the relay pulleys on high piers. One great objection, however, to wire cables, in spite of the cheapness of their first cost and their suitability for large spans, is that they do not last in good working order for more than a year, so that the charge for renewals is considerable.

Compressed air has been applied as a motive force for tramway engines to obviate the inconveniences of a steam engine in crowded streets; but by far its most important application has been its employment for transmitting power for boring headings in tunnels and mines. Here its value has proved very remarkable, as not only has it enabled the inconveniences of steam, smoke, and water to be avoided in the confined headings of a tunnel, but it has also furnished at the same time a means of providing the ventilation so much needed. The loss of efficiency, however, of this method, is very great, owing to the variations in temperature the air undergoes in compression and expansion, the loss of force in the air-compressing machines, and the friction of the air in passing along the conducting pipes. The arrangements, moreover, for cooling the air in the compressors are necessarily complicated, and, therefore, except under conditions where its efficiency is of little importance compared with its adaptability to a special purpose, it has been little used. Compressed air has been adopted for what is termed the pneumatic transmission of telegrams in London and Paris, in pipes varying between 1¼ inch and 3 inches in diameter; but in these cases it has been employed rather as a sudden propelling force than in the transmission of power to a distance.

One of the most widely extended and useful methods of transmitting force is by water pressure, especially if the force is required to be exerted intermittently. The invention of the hydraulic press by Bramah may be considered to have initiated the employment of water pressure as a means of advantageously transmitting mechanical force; but the development of water pressure machinery into its present high state of efficiency is unquestionably due to Sir William Armstrong. He was first led to turn his attention to the subject by the same wish to utilize the forces of nature that led to the establishment of the factories at Schaffhausen and elsewhere, and we might imagine, from the perfection to which he has carried hydraulic machinery, that it had occupied the whole of his time, did we not know of the other important inventions, not connected with industrial pursuits, with which his name is so honorably associated. Hydraulic machinery, or the transmission of water under pressure through pipes to work machinery at a distance, has found its special application in lifting heavy weights, opening and closing dock gates, turning capstans, raising sluice gates, moving swing bridges, and other purposes where the force is not required continuously, and where it has to be distributed to several places. For instance, at docks the steam engine for providing the necessary power can be constantly at work and store up the pressure by means of an accumulator, and distribute it through pipes to the various locks, bridges, and cranes, ready to be utilized whenever required. In transmission by water pressure there are no variations of temperature as in the case of compressed air, and there is no loss from cooling as with steam; and a large quantity of power having been accumulated is available for a large expenditure of force for a short period, such as at the time of high water, when the gates and sluices have to be worked, the swing bridges moved, and the capstans turned, which would require a far greater engine power if it had all to be generated at the time, and the engine would then lie idle for the rest of the twelve hours. The accumulator, which consists of a large cast-iron cylinder fitted with a loaded plunger, is raised, when the steam engine is compressing the water, in proportion as the pressure increases, and then continues to impart the pressure of its weight to the water till the exhaustion of the water pressure causes it to descend. This contrivance was invented by Sir William Armstrong to avoid the inconvenience of having to provide an elevated reservoir filled with water, which would indeed have furnished a larger supply of water, but would have delivered it at a much lower pressure than is now attained by the employment of an accumulator. When it is necessary to obtain rotary motion hydraulic engines are used, which are really small engines with oscillating cylinders and pistons worked by water instead of steam. Hydraulic machinery was first adopted for lifting heavy weights, and one of its latest applications has been to the working of heavy guns. Where a constant supply of water is laid on, and the water is delivered at a fair pressure, small hydraulic engines might be applied in houses to various domestic purposes. The ease, regularity, and wonderful precision with which the various operations can be conducted by hydraulic machinery have led to its being very extensively used. There is naturally a certain loss of efficiency from friction in the pipes and machinery and from leakage; but in the special class of operations to which it is applied any loss of efficiency can be compensated for by its convenience and adaptability. In general utility and efficiency water pressure may be said to be far superior to compressed air for the transmission of power; but in certain places, where leakage is objectionable, or where frost cannot be kept out, compressed air might possess the advantage.

Transmission of power by electricity is still in its infancy, and it might at first sight appear that the conversion of power into electricity, and then its reconversion into power, could not be managed economically. Electricity, however, possesses the marvelous capability of being conveyed a long distance along a conductor with hardly any loss of intensity, so that if it was desired to utilize power at a very great distance from its source, there is no doubt that electricity would afford the best and probably the only means of effecting it. Whether the vision of the future that Sir William Thomson pictured by means of the waste coal at the pit's mouth, thus saving the carriage of the coal, should, as he anticipates, be shortly realized, it at any rate serves to indicate what a wonderful power of economical transmission to almost indefinite distances is possessed by the electric current.

It is interesting to note that while M. Ziegler has turned to account the rapid currents of rivers for the transmission of power by wire ropes, and Sir William Armstrong acknowledges that he owes his first conception of transmitting power by water pressure to his noticing the wasted energies of mountain torrents, Dr. Siemens has conceived the notion that the enormous force developed by the Falls of Niagara might be transmitted to a distance by electricity.—*Universal Engineer.*

The coinage executed at the U. S. Mint in Philadelphia during November amounted to 7,550,840 pieces. 158,400 pieces were eagles, 187,280 half-eagles, 2,960 quarter-eagles, 1,600 gold dollars, 1,000,000 silver dollars, 200 each of five and three cent pieces, and 6,200,200 cents.

THE LIVADIA AT SEA.

The following communication has been sent to the London *Times* by Sir E. J. Reed, M.P., dated on board the Livadia, in the harbor of Ferrol, Oct. 25:

The performances of this extraordinary vessel have so immediate a bearing upon the future construction of steamships, both for war and for passenger purposes, that some observations upon her steam trials at the Clyde and her subsequent sea passages will doubtless be of interest to many of your readers. In the articles which you published concerning the Livadia before her completion a higher speed than many expected was confidently predicted for her, and has since been realized. I myself feel some pride in this result, for, although I have had nothing whatever to do with the Livadia beyond once visiting her after her launch, and subsequently crossing the Bay of Biscay in her, I have for several years past publicly maintained that ships like the Livadia, of small length and immense breadth, could be driven at a high speed, and in maintaining this principle I have stood almost absolutely alone in England. Owing to the enterprise of the Russian Government, the matter has now been put to the test, and a ship of only 235 feet long and with a breadth (153 feet) twice that of the Inflexible, has at her very first trials, and under some temporary disadvantages, attained a speed of very nearly 16 knots an hour. The power exerted in producing this speed has doubtless been great in proportion to the displacement and section of the vessel, but there is not a greater, nor is there, I am bound to say, a more universal delusion among nautical people than the determination of what is called "economy" by such considerations alone. In the present instance, for example, what was required was to produce a vessel of high speed and of superior steadiness, with large accommodation suitable for an emperor and his ministers and suite, and if that has been accomplished with a given expenditure of steam power, it is idle to say that the same steam power would have driven a larger and more expensive ship as fast. Economy consists in accomplishing your object by the easiest and cheapest method; the neglect of your object and the attainment of something you do not require is extravagance, however disguised. The disregard of this principle has in war ship construction cost the nations of Europe many a million.

The Livadia, as completed, has more immersion than was contemplated at the time of her design, and I have ascertained the following figures:

	Displacement.	Mid Section.
As designed	4,000 tons	900 square feet.
As tried at measured mile	4,420 "	1,000 " "
At departure from Greenock	4,720 "	1,075 " "
At departure from Brest	5,070 "	1,150 " "

The reason assigned for these increased immersions is that the experiments of Dr. Tideman at Amsterdam showed that in a ship of the Livadia's form the loss of speed from increased immersion was exceedingly small, and that consequently, as the ship approached completion, no objection was offered to increase of weight where increased conveniences were suggested, and that many additions were in this way made. For the same reason the quantity of coal taken on board first at Greenock and afterward at Brest, was only limited by other considerations. She left Brest with 850 tons of coal on board.

In view of the exhaustive discussion of the ship's probable speed, which you published on the 9th of July last, it seems unnecessary to again compare the Livadia with other vessels, but it may be for the convenience of many readers, whose interest in the question is great, to say that while the immersion was greater than was then anticipated, so also was the power developed. The figures employed by you in July, on Captain Goulaeff's authority, compare with the actual figures of the subsequent trial as follows:

	Displacement.	Section.	Average indicated h. p.
Data of July 9	4,000 tons.	900 sq. ft.	1[illegible],[illegible]00
Data of measured mile trials	4 420 "	1,000 "	12,3[illegible]4

The mean speed of six runs was 15·864 knots.

It will be observed that the increases of power and immersion were nearly proportional, so that the comparisons given by you on the 9th of July remain practically undisturbed. The performance of the Livadia at high speed was, therefore, between two and three knots per hour inferior to that of a long fine-lined frigate like the Shah of proportional size and power. This difference is so very small compared with what the nautical world has been predicting that the full-speed trials of the Livadia must be pronounced a splendid success, and a demonstration of the fact which few but myself recognized, viz., that very great breadth of ship is compatible with very high speed. It is but fair to quote in this connection the following sentence from your article of July 9: "The new yacht has a far better chance of attaining a high speed than the philosophers of the last century could possibly have acceded to her under their theories of resistance, and it is not by any means extravagant to hope that those may be disappointed who consider it impossible to drive so broad a vessel fast."

Before we left the Clyde Admiral Popoff showed me a letter which he had addressed to yourself, and in which he had pointed out some of the disadvantages under which the steam trials were made. The success of the ship as regards speed is so great as to render it needless to insist upon these disadvantages, in so far as she is herself concerned, but it is of great importance to science to have it remembered that it was at her very first trials that a vessel of her proportions steamed nearly 16 knots. The Livadia has three screw propellers, and while there was but little experience to guide the Admiral in selecting for them the best dimensions, etc., there was none to guide him in fixing their relative positions, pitches, and other conditions. It is also highly probable that even under the best conditions three screws may propel such a form of ship less efficiently than either two screws or one. In view of all the facts, therefore, it appears probable that the deficiency of speed which is solely due to the form and proportions of the hull, as compared with the best ships of ordinary form, is still less, much less than even the trials of the Livadia might at first sight suggest.

Like considerations to these will, of course, apply more or less to all the steam performances of the Livadia for the present, but it will nevertheless be instructive to observe briefly her ordinary steaming qualities. On the 14th of October, at her earliest essays at steaming, she steamed at 11 knots per hour with 2,969 indicated horse power, 13 knots with 4,770 indicated horse power, and 15 knots with 10,037 indicated horse power. This was in smooth water. At sea, when the wind and waves were moderate, she has run over long distances since we left Greenock with about 4,500 horse power, at a speed varying from 12 to 13 knots. It is not easy to select other ships of approximately equal steam power and displacement combined, but two of our ironclads come near to the Livadia, and I will give the comparison between them:

Name of ship.	Displacement.	Horse power.	Speed.
Penelope	4,394 tons.	4,703	12·7 knots.
Orion	4,750 "	4,000	12 "
Livadia	4,420 "	4,770	13 "
"	4,720 "	4,500	12½ "

The speed of the Orion given is only estimated, but that is of no consequence, because the object of this comparison is merely to show that the Russian Popoffka, modified as in the Livadia, are capable of steaming at ordinary speeds with moderate power, and by no means contrast absurdly, as some suppose, with all other ships.

I must now say a few words upon the behavior at sea of this remarkable vessel. In several articles that have appeared in your columns of late the public have been advised not to expect too much from the sea-going performances of the Livadia. Her extreme lightness of structure has been pointed out, and the probability of her sustaining heavy shocks and great vibration has been mentioned. On the 9th of July you said: "When waves are encountered at high speed, and the speed of the oncoming waves is virtually added to that of the ship, the qualities of the Livadia will probably be put to by far the most serious tests that await them." This prediction has been literally fulfilled on our passage across the Bay of Biscay. It was fine when we left Brest on Tuesday evening last, but we had been only a few hours at sea when the barometer began to fall and bad weather set in. It would have been prudent, perhaps, to have put back into Brest, considering the very light draught of our ship and the towering heights of deck palaces which are piled upon her lightly-built upper deck. But the Grand Duke Constantine, the Lord High Admiral of Russia, was on board, and considered the opportunity of thoroughly testing the vessel too fine a one to be lost, and we consequently steamed away into the very teeth of a Bay of Biscay gale, which steadily grew angrier and wilder as we advanced all Wednesday, and during that night and the following morning blew at its hardest, accompanied with very heavy seas indeed. The actual rolling and pitching of the Livadia at the height of the gale was exceedingly small, never exceed-

ing 4° for the single roll, or 7° for the double roll, or 5° for the forward pitch, and 9° for the double pitch, so to speak. This horizontal steadiness was most remarkable, and, while in very agreeable contrast with my experiences of the last three years at sea in ordinary ships, was full of significance as regards the possible steadiness of gun platforms in ships of war. When we at length had crossed the Bay and got out of the gale, and steamed into Ferrol, not the slightest damage of any description had been sustained (with an exception to be mentioned hereafter), either to the vessel or to her boats, palaces, furniture, crockery, or anything whatever. The dinner-table was laid, the candelabra stood upon it, and the meals were served throughout the voyage, even during the storm of Wednesday evening, exactly as if the vessel had been at anchor in port. The broad covered gallery which extends all round the open deck was never reached by the sea, and it was only during the worst of the weather that even spray invaded it. With a vessel of such very light draught (7 feet) in such gale, and with such high and lumpy waves, the blows of the sea under the flat bottom were at times tremendous; but the confidence of the Grand Duke in refusing to turn back was justified, and both Admiral Sir Houston Stewart, the Comptroller of the Navy, who was on board, and myself are indebted to his Imperial Highness for a most instructive piece of sea experience. Sailor as Sir Houston is, and intimate with the latest forms and details of naval construction, it was impossible, nevertheless, for him not to profit by this very exceptional voyage on this very exceptional ship.

Before entering Ferrol, one of the small compartments forward was found to be filled with water, and it was soon discovered that one of the bow plates had been stove in, and the plates in the neighborhood strained and made leaky. My own first impression was that the cellular bow had yielded to the direct impact of the sea during one of the most violent of the shocks which were felt; but a close inspection of the injuries led us to the conclusion that the bow had been struck by some floating wreckage. We are now temporarily repairing the damage, for which, owing to her extreme subdivision into watertight compartments, the vessel is but little the worse. I will reserve for a future occasion, should it arise, my views of the lessons to be learnt and the inferences to be drawn from the sea performances of the Livadia.

Engravings of this remarkable vessel will be found in SCIENTIFIC AMERICAN SUPPLEMENT, No. 243, page 3867.

THE HERRESHOFF LAUNCH.

CHIEF Engineers Isherwood, Zeller, and Carpenter have made a preliminary report upon the Herreshoff launches, two of which were tried in Bristol, R. I., in competition with a navy steam launch. All three were of wood, and nearly the same in dimensions, 33 feet 1 inch x 8 feet 9 inches for the Herreshoff, and 33 feet 8½ inches x 8 feet 7 inches for the navy launch. The navy launch was coppered, the others smoothly painted. The Herreshoffs, with everything on board and seven persons, drew 1 foot 7 inches, displaced 8,929 lb. at the draught, and weighed 6,555 lb.; the navy launch, similarly equipped, and carrying four persons, drew 2 feet 2 inches, displaced 16,682 lb., and weighed 13,364 lb. One Herreshoff had a compound engine with two cylinders of 4½ and 7 inches diameter, 7-inch stroke of piston; the engines of the other had two cyliners of 4½ inches diameter and 7-inch stroke; the engines of both boats were condensing engines fitted with surface condensers, and the cylinders connected at right angles. The combustion in the boilers was by natural draught. The navy launch had an engine with a single non-condensing cylinder; combustion in the boiler by the blast of the exhaust steam delivered into the chimney. The screw was four-bladed, 35 inches diameter and 54-inch pitch; those of the Herreshoffs were brass, four-bladed, 31·3 inches in diameter, 4·6 long, and 44-inch pitch. The Herreshoff boilers had 6 square feet of grate service; the navy boiler of the cylindrical return tube type with 6·5 square feet of grate service.

The experiments covered every possible variation of speed, boiler pressure, measure of steam expansion, speed of piston, and an extensive series of experiments on superheated steam under the conditions of different steam pressures, speeds of piston, and measure of expansion. About 24,000 indicated diagrams were taken during the ten weeks of uninterrupted work during June, July, and August last. The coal (anthracite) and refuse from it were weighed and the feed water measured. Until the data obtained are reduced and the results generalized no exact facts can be given, but the general conclusions are as follows:

"In all the particulars of models, construction combination, strength, finish, lightness, quality of material and workmanship, the Herreshoff steam launches are incomparably superior to the navy launches, a superiority resulting from the fact that the latter are only occasionally designed and built at the navy yards, and then by persons whose skill and experience lies in the designing and construction of large vessels, and who devote little or no attention to what is considered as comparatively a small matter, but which, if the highest excellence is to be attained, requires much special training and experience." "The system of machinery employed in the Herreshoff launches is quite original in most of its details. It is diametrically opposite to that which is used in the navy launches, and is in every particular greatly superior to the latter." "The military value of the navy launches in expeditions, towing boats, carrying dispatches, etc., is very limited; and any system that would increase their efficiency in this respect should be promptly adopted."

The control of the Herreshoff launches is complete, "there being no time lost and no uncertainty in the starting, stopping, and backing. The boiler is practically inexplodable, and is absolutely safe, both on account of its strength and of the very small quantities of steam and water which it contains. It is a coil boiler, the lightest ever constructed for its power, and the weight of water contained in it is the least. This is the only part patented. "The continuous service of the launch is thus limited by only the weight of coal it can carry, and not by the weight of water it can carry. The bunkers can easily and quickly be refilled from other vessels at any locality, but the filling of tanks with fresh water can only be done where fresh water can be obtained."

The length of time it can steam, and its freedom from noise, give the Herreshoff a special military value. The navy launch carries about 960 lb. of coal and 2,500 lb. of water, and in smooth water can steam seven statute miles an hour for four hours, after which the tanks must be refilled. The Herreshoff launch carries 1,120 lb. of coal in the bunkers, and can maintain a speed of seven statute miles for twenty-eight consecutive hours, after which the bunkers must be refilled. But if there be added to the fuel weight the 2,500 lb. in water in the navy launch, then the consecutive steaming of the Herreshoff launch can be extended to ninety-eight hours. The maximum speed of the navy launch was 8·5 statute miles per hour, and of the Herreshoff launch 11 statute miles per hour. The Board say in conclusion:

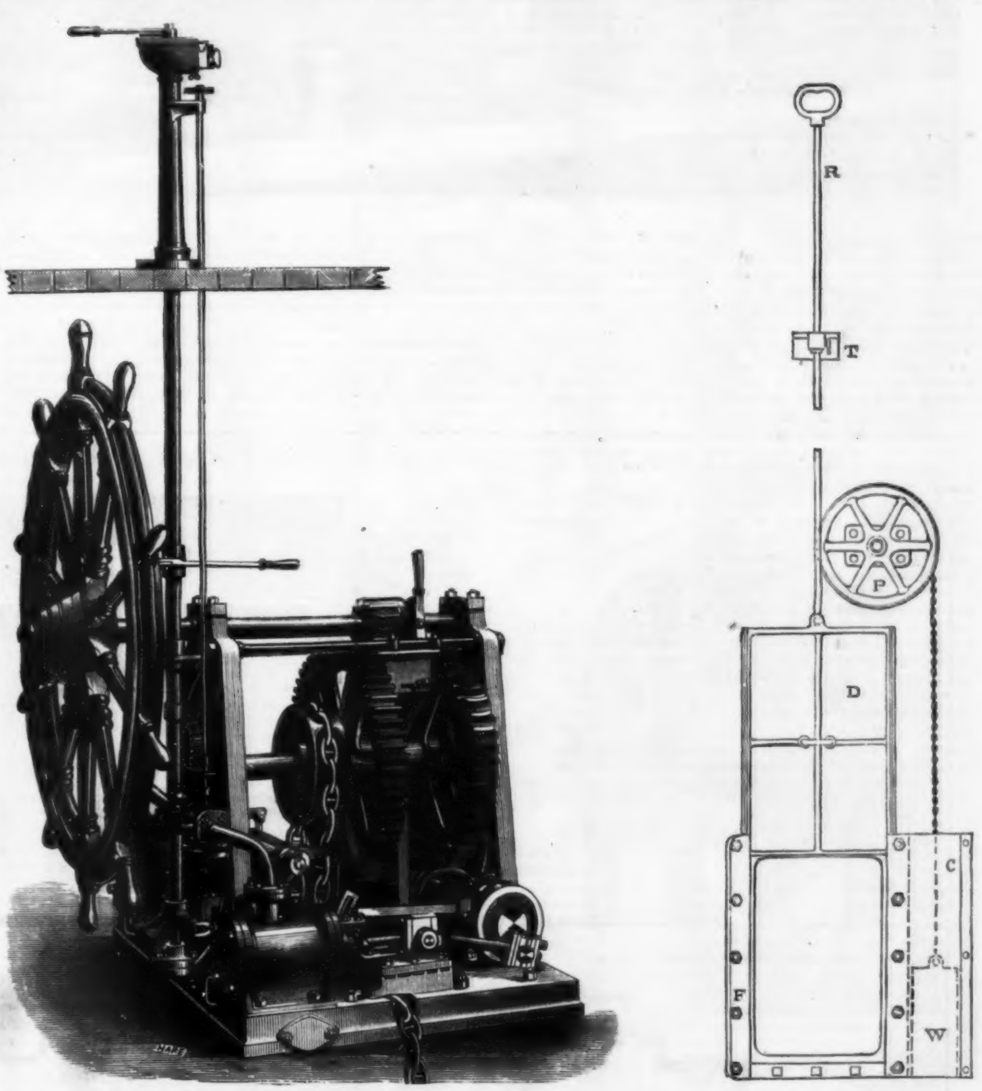
When the two launches were tried together in very rough water against a strong head wind and sea, the superiority of the Herreshoff launch was much more marked than in smooth water. While the navy launch took in so much water over the bows as to endanger her safety, and to require constant baling with buckets, the Herreshoff launch was dry. She was much better trimmed, lighter, more buoyant, and every way superior in nautical qualities to the navy launch, at the same time making double the speed. As regards economy of fuel, the Herreshoff launch develops the indicated horse power with less than half the coal required in the navy launch. In every particular the superiority of the Herreshoff launches to the navy launch was so marked as to be apparent to the most cursory observation. Their weight was one-half and their economy of fuel was double, their nautical qualities much finer, their carrying capacity was greater, their finish and general arrangement were better, they were noiseless, and their capability of continuous service was enormously greater. The superior adaptability of the Herreshoff system to that of any other known to us, for steam launches, steam yachts, steam pinnaces, torpedo boats, small gunboats, etc., is so unquestionable that, after the most extensive experiments and thorough examination of the subject, we are constrained to recommend it, though comparatively new, to the serious attention of the department for such classes of vessels. The management of the boiler differs from the management of boilers of other types, but is soon acquired by the humblest intelligence, and we believe the engineering of the navy should be familiarized with it as speedily as possible, as its use is certain to extend as its merit becomes understood.

NEW STEAM STEERING GEAR.

THIS combined hand and steam steering gear, which among many other vessels has recently been fitted to the steamship Triumph, three thousand tons register, built at Middlesbrough by Messrs. R. Dixon & Co., for Messrs. Macintyre, of Newcastle-on-Tyne, is one of the simplest yet designed, and is chiefly remarkable on account of its cylinders being worked by the ordinary link motion. The cylinders are also so arranged as to require no drain cocks, the condensed water being all carried out through the exhaust port immediately the machine commences to work. It occupies very little space, and as there are no spur wheels in gear when steam is being used, noise and vibration are reduced to a minimum. The steam gear can be worked either by a short tiller or by a small hand wheel, as may be preferred, from the upper or lower bridge, as may be required, without any change being made in the gear. The machine stops immediately the rudder arrives at its desired position, and remains fixed there until another change is required.

Messrs. R. Roger & Co., of Stockton, Eng., are the sole manufacturers of this gear.

The engraving explains itself. Two horizontal cylinders drive a crank shaft on which is a worm, which actuates a worm wheel, the shaft of which carries a chain wheel, which takes the rudder chains. The ordinary hand steering wheel is thrown in or out of gear at pleasure, as shown.

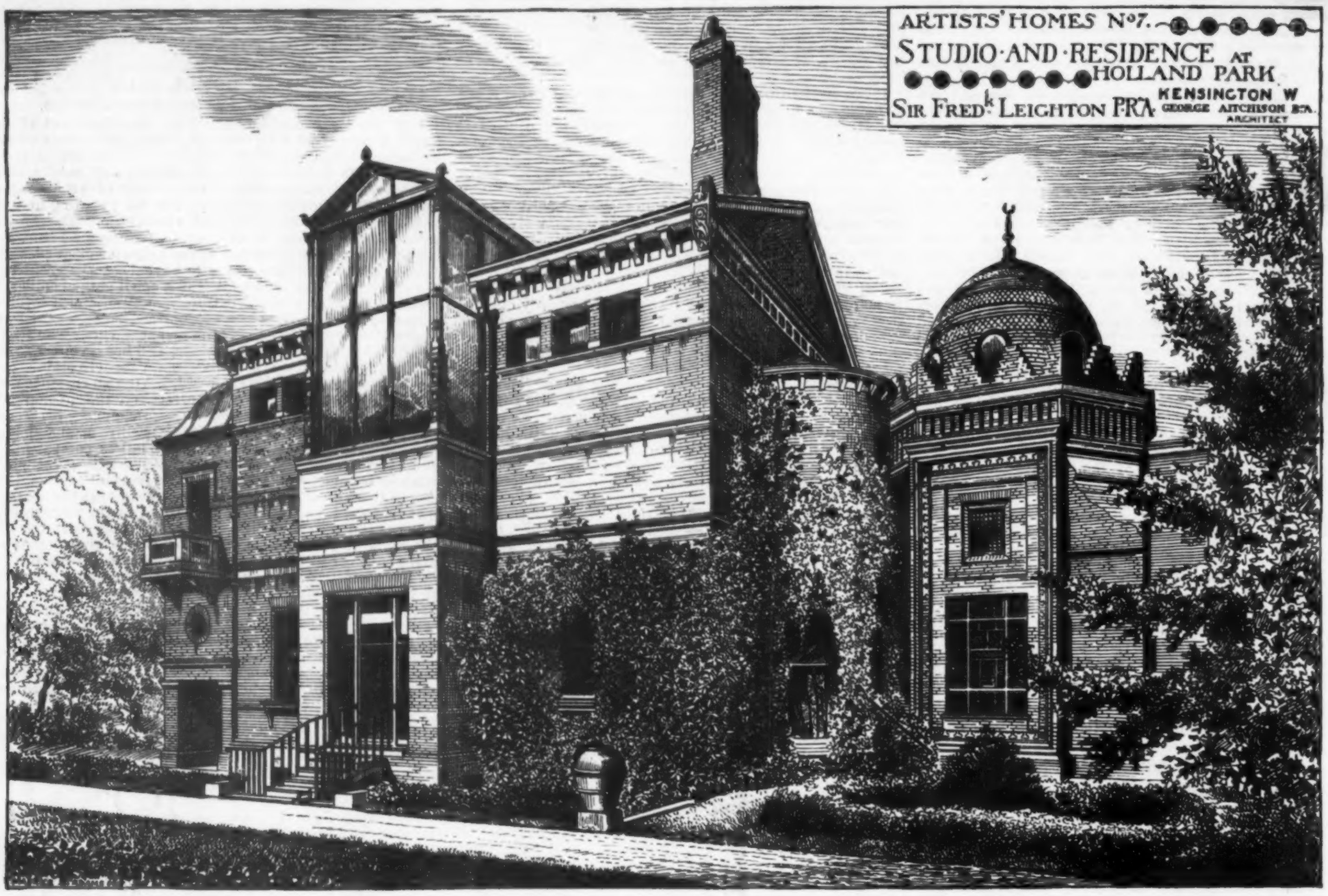


STEAM STEERING GEAR.

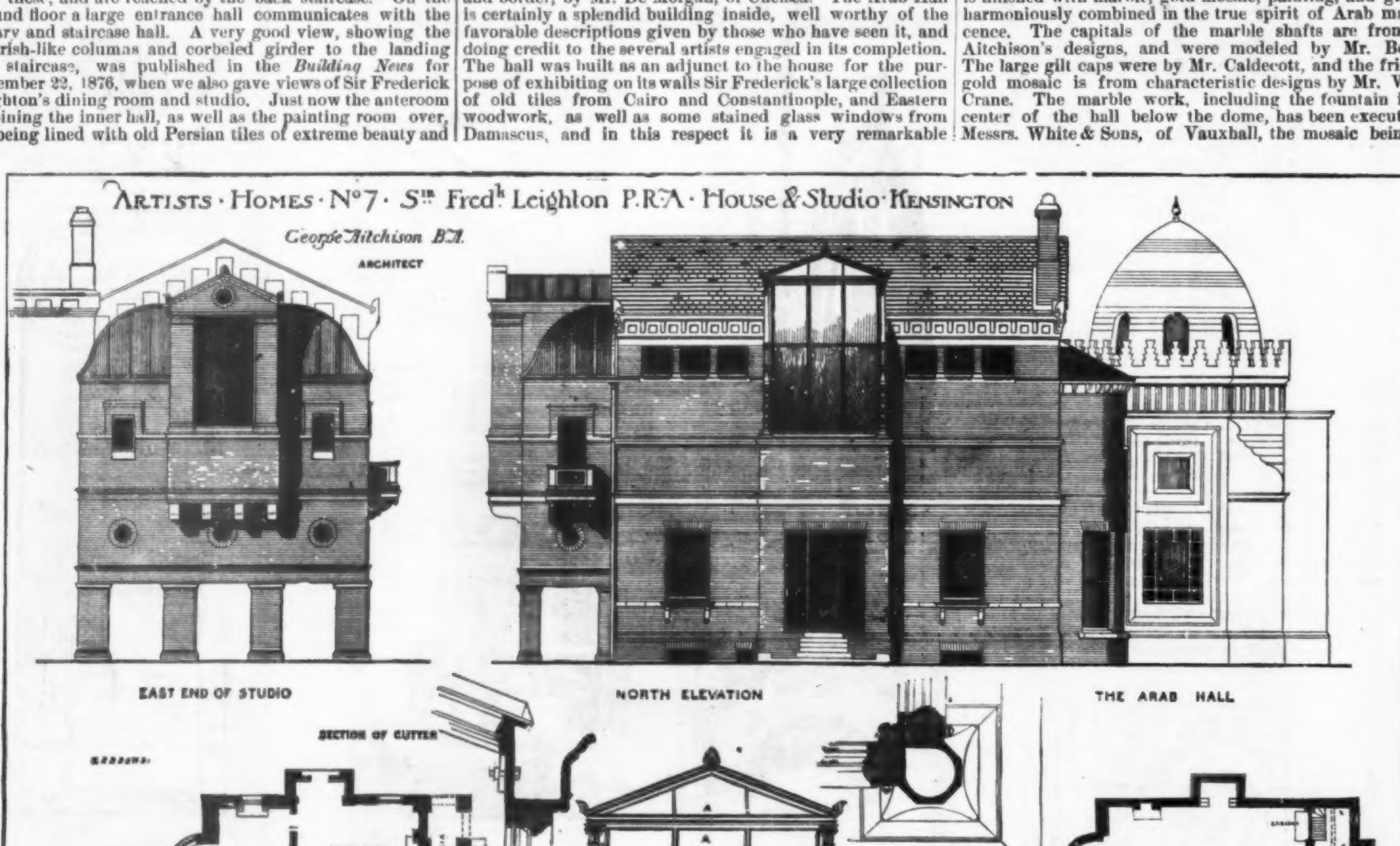
ARTISTS' HOMES, NO. 7.

SIR FREDERICK LEIGHTON'S HOUSE AND STUDIO.

THE private house and studio of the President of the Royal Academy of Arts, illustrated next page, can scarcely be deemed to be a pure example of one architectural style, while, in its decoration and furniture, not only several styles, but several periods of the history of art are represented. The main idea, of course, in the planning here, as in all painters' houses, has been the studio. The greater part of the first floor is devoted to its appointments, and the chief or garden elevation of the house is governed by its requirements. No care seems to have been spared in providing a grand approach to it, and a small ante-chamber, or painting-room, as it is called, immediately adjoining its chief entrance, adds apparent size by contrast, giving at the same time a luxurious air to the entire arrangements. The studio itself is 58 ft. long, and 25 ft. wide, and has a gallery at the east end for statuary and hangings. A model's stair is conveniently arranged at this same end, having an entrance-door most suitably placed, as will be seen on the ground-floor plan, at the side of the house. Under the gallery Sir Frederick's colors and materials are carefully arranged in a purpose-made sort of cabinet, with endless compartments and pigeon-holes. A raised dais below the great north window occupies the central recess on that side of the studio, and at the west end an apsidal recess continues the arrangements of the semicircular bay of the drawing-room below. The general coloring of the walls in the studio is Indian red, the woodwork here, as in the rest of the house, being black and gold. The chimneypieces throughout are marble, inlaid in geometrical design, and the cabinets at the east end, in front of the gallery, are from the special designs of the architect. The large window already referred to, and of which we give several details, is glazed with two thicknesses of glass, both in the top and sidelights, the object being to prevent the too rapid cooling of the air in cold weather. The sunlights are so arranged that no air can come in except when they are lit. The heating of the room is by three open fireplaces, and the blinds of the large window are of dense canvas (of the same color as the walls) and fixed on rollers. The chief interest in the studio will be found in the large series of sketches in oil, arranged on the walls, illustrating scenes from all parts of the world, and recording reminiscences of the most varied character, but here hung side by side, while on easels, placed here and there, are portraits, more or less in a completed stage, but all remarkable likenesses of important people. Of these the unfinished portrait of Sir Frederick Leighton himself, now being painted by his own hand, at once attracts notice. It is a life-like and truthful picture, showing how its author has aged since Mr. Watts painted the same portrait some three or four years ago. The top-lit painting-room outside the studio adjoins, as we have said, and beyond, through the lattice gallery shown on our plan, most interesting peeps are obtained of the sumptuous Arab Hall beyond. The rest of the first floor is occupied by Sir Frederick Leighton's bed-



room and private apartments. The servants' bedrooms are over these, and are reached by the back staircase. On the ground floor a large entrance hall communicates with the library and staircase hall. A very good view, showing the Moorish-like columns and corbeled girder to the landing and staircase, was published in the *Building News* for December 22, 1876, when we also gave views of Sir Frederick Leighton's dining room and studio. Just now the anteroom adjoining the inner hall, as well as the painting room over, are being lined with old Persian tiles of extreme beauty and admirably copied, for the making good of the deficient parts and border, by Mr. De Morgan, of Chelsea. The Arab Hall is certainly a splendid building inside, well worthy of the favorable descriptions given by those who have seen it, and doing credit to the several artists engaged in its completion. The hall was built as an adjunct to the house for the purpose of exhibiting on its walls Sir Frederick's large collection of old tiles from Cairo and Constantinople, and Eastern woodwork, as well as some stained glass windows from Damascus, and in this respect it is a very remarkable museum. The whole interior is thoroughly well done, and is finished with marble, gold mosaic, painting, and gilding, harmoniously combined in the true spirit of Arab magnificence. The capitals of the marble shafts are from Mr. Aitchison's designs, and were modeled by Mr. Boehm. The large gilt caps were by Mr. Caldecott, and the frieze of gold mosaic is from characteristic designs by Mr. Walter Crane. The marble work, including the fountain in the center of the hall below the dome, has been executed by Messrs. White & Sons, of Vauxhall, the mosaic being the

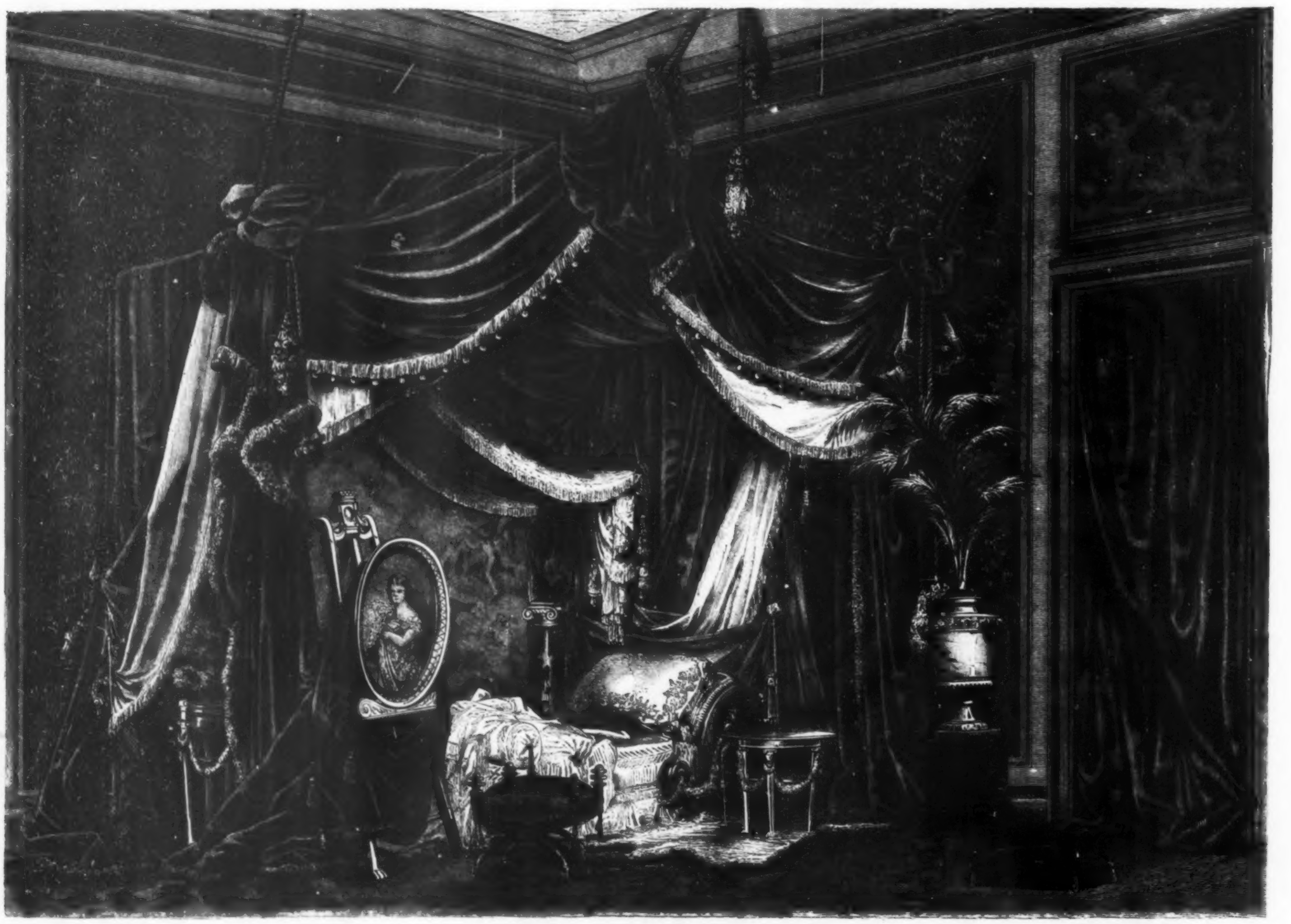


SUGGESTIONS IN DECORATIVE ART.—INITIALS BY EISENLOHR AND WEIGLE, STUTTGART.—*From the Workshop.*

work of Messrs. W. H. Burke & Co. Messrs. Harland & Fisher, of Southampton street, carried out the painted decorations, from the architect's designs. The plaster work was by Mr. Riche, and the painted glass by Mr. Ross, of Harrow. The general building was the work of Messrs. Woodward, of Finsbury, the builders.

Next week we propose to publish two drawings of the Arab Hall, taken from those which Mr. Aitchison exhibited this year at the Royal Academy, and showing the decorations as completed. The ante-corridor to the Arab Hall, to which we have already referred, will have a black dado below the mural tiles now being fixed, and the ceiling, like the cornice, will be gilt. A mosaic pavement has been prepared for the floor, in the center of which a pedestal of brocatello will be placed, supporting a Roman figure in bronze. The drawing room was designed for the exhibition of four fine panels of "Morning," "Evening," "Noon," and "Night," and of a circular sketch, by De la Croix, in the ceiling. The chimneypieces, cabinets, some of the chairs and bookcases, were specially designed for this room by the architect to the house, who also designed the large sideboard and hooded mantelpiece in the dining room. The exterior is faithfully shown by our view to-day, while the geometrical drawings carefully illustrate the planning and details of the house. The big window to the studio is chiefly of iron construction, with mahogany sash bars and frames. The cornice is massively built of stone, of which material the main string and projecting balcony on the right are alone exclusively composed, the chief material, both for the Arab Hall and house, being red brick for the walls, with red tiles for the roof. Stone, however, is far more freely used in the road front of the house, where the building has a forecourt of about twelve or fourteen feet facing the Holland Park road. A large garden extends to the back of the house and to the rear of Mr. Marcus Stone's house and grounds in the Melbury road, and it adjoins the plot occupied by Mr. Val Prinsep, A.R.A., whose studio, by Mr. Philip Webb, will form the subject for the next illustration of "Our Artists' Homes" series. In conclusion we may mention that two or three additions to the original design for this house have at different times been made. For instance, the gallery and projecting end has been added to the studio, and the north window for light's sake was changed from a similar structure of stone to the iron arrangement as we now see it. The Arab Hall has since also been entirely added. A good photograph of the house has been taken by Bedford Lemere, and the architect has likewise lent us several from the interior, so that by the aid of these and the working plans, we have been enabled to present our readers with a rather unusually complete set of illustrations of this remarkable house, especially if the drawings now given are taken together with those illustrated by us in 1876, already referred to, and those to be published next week. Mr. George Aitchison, B.A., of Harley street, was the architect to the house, and the decorations throughout have been and are still being continued under his immediate superintendence.—*Building News.*

IT is said that a Swiss watchmaker at Lugano has a large and well trained stock of carrier pigeons, which he employs in smuggling watches into Italy. The watches are small, and are tied to the pigeons' feet.



SUGGESTIONS IN DECORATIVE ART—RESERVED PART OF A GREAT SALOON BY H. PENON, PARIS, FROM THE PARIS EXHIBITION.

GREAT SALOON.

OUR engraving shows a reserved part of a great saloon filling one of the corners of the room, by H. Penon, decorator, Paris.

The arrangement represented here allows the reception of intimate visitors in the great drawing-room itself; thus it serves as a substitute for the ancient boudoir which has become obsolete in the mansions and palaces of modern aristocracy. The fittings and accessories, such as a child's portrait placed on an easel, the choice of quiet shades of color harmonizing with the tapestry or hangings of the walls, characterize the room as being appropriated for a young mother, the lady of the house.—*The Workshop.*

COLOGNE CATHEDRAL.

THE HISTORICAL PROCESSION AT THE COLOGNE CELEBRATION, OCTOBER 16, 1880.

THE most interesting and the crowning feature of the festivities at the completion of the Cologne Cathedral was the historical procession. Of the cathedral itself so much has recently been said and so many illustrations have been printed that even those who are not fortunate enough to have been of the "innumerable throng"—of tourists—that has entered its portals, may form a good idea of the grandeur and immensity of the imposing edifice. We shall, therefore, not attempt the description of this architectural wonder; but will give an account, as near as we can, of the historical procession, illustrative of the history of the various periods of the building.*

The procession was divided into three parts, and embraced the history of the cathedral from 1248 to 1842. First was a representation of the pageantry which attended the laying of the foundation stone in 1248; the second represented the consecration of the choir in 1332; and the third the ceremonies of the beginning of the restoration and continuation of the building under the auspices of King Frederick William IV., in 1842.

The first group of the first period was organized after designs and under the direction of Fritz Roeber, a Düsseldorf painter. It was preceded by a band of trumpeters in old German attire; after which rode the Cologne herald with mounted attendants in armor; next followed the city and imperial standard bearers, accompanied by mounted warriors, and then two burgomasters with councilors and bailiffs. The group was closed by patricians and burgesses of Cologne, with their wives and children, followed by the golden shrine of the Holy Three Kings, the most precious relic of the cathedral, borne on the shoulders of eight goldsmiths' journeymen.

The second group of the first period was arranged after the designs and directions of Ernst Roeber, of Dusseldorf, and was preceded by a band of music on foot, attired in old German garb, after which came the Count and Vogt of the city, richly mounted and armed, with six mounted men-at-arms gayly clad in the city (or Hanseatic) colors, followed by the imperial and royal standard bearers, who preceded a squad of exalted personages—William, King of Holland; Cardinal Capocci, the Papal Nuncio; Archbishop Conrad, of Hochstaden, the founder of the cathedral. The kinsmen of the Dutch king, the Dukes of Limburg and Brabant rode at either side of the archbishop. A crowd of vassals of the archiepiscopal see, and Dutch and German knights and noblemen, with wives and children, pages and attendants, closed this part of the group.

A triumphal car (designed by the Cologne architect, Pflaume), drawn by four gorgeously caparisoned horses, came next, and conveyed the first architect of the cathedral, Gerard, of Rile, and a number of his workmen bearing tools emblematic of their handicraft, while in front stood Colonia wearing a mural crown and holding the plan of the cathedral. From the center of the car rose a model of the derrick used in laying the foundation stone. This was surrounded by a brilliant galaxy of dames and damsels dressed in the costume of the thirteenth century. Men-at-arms mounted, and clad in the colors of the City of Cologne, closed this period.

Next came the first group of the second period (designed and arranged by Prof. Alb. Baur, of Düsseldorf), ushered in by a mounted music corps of hussars, followed by cross-bowmen mounted and a-foot, the genealogical herald of the old Cologne families, their standard bearers, and the banner men (designated Heroes of Cologne), with a number of citizens, fallen at the battle of Ulric's Gate, and pages and attendants. Two members of the renowned Cologne family, Overstolz, Gerhard and Rütger, the last the stormer of Bayen-Tower, were next; then arquebusiers and cross-bowmen who preceded a war chariot (designed by Prof. Christ. Mohr, Cologne) of the battle of Worringen, drawn by four horses and manned by stalwart warriors. Cross-bowmen, a music corps a-foot, and an array of old Cologne notabilities with their wives, standard bearers, pages, and men-at-arms ended this group.

The second group of this period (arranged by Wm. Beckmann, Düsseldorf), began with a war ship of the Hanseatic League, designed by the artist, V. St. Lerche. The vessel was beautifully ornamented and beflagged, and conveyed a bevy of fair ladies, representing the cities of the League, with crowned heads and richly and quaintly made costumes. In the prow stood a mailed knight, while at either side were pikemen in armor, guarding a captured pirate and his mistress.

A heavy and lumbering freight wagon, escorted by mounted troopers, came next. Then followed a choir of forty children, after them Archbishop of Virneburg, as lord of the land, with pages and attendants; then a brilliant array of princes and noblemen of the Rhineland and Holland, donors of the painted windows of the cathedral choir; then a car conveying a model of the cathedral choir and the architect, Master Johann, and his colleagues; following this were the federal charter, the several city guilds, a huntsman with a pack of hounds—all with banners, music, and implements of their various trades, forming a strangely picturesque group of ancient tools and paraphernalia.

The third and last period, in one group (Prof. Campbausen, of Düsseldorf), representing times comparatively modern, began with a leader of the "Landsknechte," accompanied by his pikemen with a corps of kettledrums and trumpets, a herald, a banner bearer, cavaliers as guards of honor, the banner of the Cathedral Building Association, sur-

* A description of the great cathedral, with excellent engravings, will be found in SCIENTIFIC AMERICAN SUPPLEMENT, No. 257.

rounded by masons, etc.; a car with a facsimile of the old crane which stood nearly three hundred years on the unfinished tower of the cathedral, and was considered, so all the guide books tell us, the true sign of Cologne; following this were imperial pages, and then came a triumphal car (Prof. Ch. Mohr, Cologne), conveying a statue of Germania, in heroic size, in the act of crowning a model of the completed cathedral. At the base of the pedestal sat four ladies representing the "Watch-on-the-Rhine."

The procession was closed by a squad of each of those forces which had fought in the war of 1870 and 1871. As a sign of their peaceful intentions their arms were ornamented with flowers and wreaths.

And thus passed in review the historical procession which will be the pride of Cologne, next to the cathedral, for years to come, and was the wonder and admiration of all who saw it. A mere enumeration of the persons and paraphernalia of the procession is not difficult; but it is quite otherwise when one comes to describe the picturesqueness of the festively clad ladies and knights and the fierce-looking warriors, exalted officials and attendants, with their superbly caparisoned horses and antiquated armor that made up its pomp and pageantry. In the minutest details strict historical accuracy was observed. Those who had charge of the organization of the procession were gentlemen of wealth, culture, and artistic taste, having a thorough knowledge of the periods it was to represent, and they spared neither pains nor expense in carrying out their ideas, and their efforts were crowned with a complete success. What is here lacking in description must be left to the pencil of the artist and the imagination of the reader.

Cologne, October 18, 1880. F. A. H.

MANTELPIECE IN WALNUT.

Designed and executed by E. CARPENTIER, Carver and Decorator, Paris.

THIS mantelpiece, style Renaissance, is carved in red stained walnut, inlaid with colored marbles and enriched with a portrait in the center of the upper part; the caryatides and the ornaments which show the metal treatment are relieved by dark walnut ground. The fringed embroidery in front is wrought in gold on red and green velvet.—*The Workshop.*

SUGGESTIONS IN DECORATIVE ART.—MANTELPIECE IN WALNUT.—BY E. CARPENTIER.

A NEW battery is being produced, having one of its elements composed of sheet iron less than the ten thousandth of an inch in thickness.

EXHIBITION OF GAS AND ELECTRIC LIGHT APPARATUS, GLASGOW.

THE exhibition of apparatus for the utilization of gas, electricity, and oils, was open in the Burnbank Drill Hall and grounds, Glasgow, from the 28th of September to the 28th October. Although closed as an exhibition the trials of some of the apparatus exhibited are not yet completed. To the electric lighting apparatus and to some of the trials we shall now refer. Among other systems exhibited were the Lontin, by Messrs. Clark, Muirhead, & Co., who showed one of their sets of apparatus consisting of exciting machine and dividing machine for producing alternating currents. This set of apparatus is said to produce about eight lights of 1,500 candles each, measured horizontally; in reality the light given by each was much about the same as the continuous current Brush lights. Those showing this system preferred to put it on a level with the observer's eye as much as possible, and aided it with reflectors. There were only three lamps actually worked with the apparatus, and it made considerable noise. It was at the last moment withdrawn from the competition with the other systems, so that we have no means of forming a judgment as to the horse power used in obtaining the current. This is much to be regretted, as so much has been urged for and against the alternating current system that it would have been very interesting to have had these conflicting statements set at rest by the conclusive series of tests proposed to be applied by the committee of jurors. Before proceeding to describe the apparatus exhibited by the Anglo-American Company, and Messrs. Crompton & Co., we will here briefly describe the series of tests through which the latter apparatus has already passed, and through which the Brush system shown by the Anglo-American Company will have to pass this week.

First, in order to obtain the horse-power necessary to produce a certain current through a certain resistance, the belts driving the dynamo-electric machine were passed between the double pulleys of a novel form of dynamometer. This, we believe, is the invention of Herr Heffner von Altenech, and was described fully by Dr. Hopkinson in his paper on electric lighting, read before the Institution of Mechanical Engineers, April, 1879. Briefly it may be described as follows: The upper and lower parts of the belt passing round the driving pulley of the motor and the driven pulley of the dynamo-electric machine, are compressed by being passed between a pair of small pulleys, which revolve in contact with its outer surface. These are maintained in a frame at a certain fixed distance apart. It is evident that if the weight of the pulleys and their frame carrying them be truly balanced, the middle point of the line connecting their centers will be in line with the centers of the driving and driven pulley. But this will be only so long as no work is being transmitted by the belt. The moment any pull is put on the belt, then the middle point mentioned above will be drawn away from the center line toward that part of the belt which is most in tension, *i. e.*, toward the pulley side. This tendency being counterbalanced by a suitable spring, controlling recording points, it is, by means of a formula, which we will give in another impression, easy to calculate the horse-power transmitted by the belt.

The dynamometer appears from the frictional indicator diagram, copies of which we propose to publish in our next article on this subject, to have required 0·91 horse power to drive it, when the belt speed was 1,700 ft. per minute. The power transmitted to the pulley of the dynamo-electric machine being thus obtained, the current generated was measured by a Siemens electro-dynamometer. Two of these were provided to check each other, but at an early stage the mercury contact was blown out of one of them; however, their readings had been so far alike as to make the committee consider that the readings of the remaining one were reliable. From the dynamometer, leading wires were taken to the lamp under test. This was hung about 5 ft. from the ground, and backed by a screen of black velvet; at every 7 ft. or 8 ft. perforated screens of black velvet were placed so as to effectually exclude any extraneous light, other than that of the lamp under test, from entering the dark chamber of the photometer. We believe that ten readings of the photometer were taken for each adjustment of the standard burner, which was a moderator lamp burning a given number of grains of sperm oil per minute.

Dr. Hopkinson and Dr. Wallace took the photometer readings; Mr. Bottomley the electro-dynamometer readings; and Mr. Mortimer Evans, assisted by Mr. Thomson—Professor James Thomson's son—took the Von Altenech dynamo-meter readings. Mr. Crompton himself, under the superintendence of Mr. Bottomley and Mr. Shoolbred, took indicator diagrams, six pairs for each Gramme machine that was tried. The same lamp was used throughout the trials of Mr. Crompton's apparatus. The photometric tests were originally fixed for Thursday, 28th ult., but owing to the delay in fixing the dynamometer, nothing was actually done beyond testing the resistances of the Lontin apparatus, until 9 P.M. on Friday. Then the Lontin was withdrawn from competition, and Mr. Crompton's apparatus being ready, the programme was carried out. Three Gramme machines tested in order: (1) A Gramme machine, A pattern, made by Emerson, Murgatroyd, & Co., of Stockport, No. 93. (2) A Gramme machine made by Sautter and Lemonnier, of Paris. (3) A Gramme machine made by M. Mignon Rouart, of Paris.

The third, a Mignon Rouart's machine, was much the best, gave far the heaviest current, and the best light, but we do not propose to give particulars of these machines until we can publish the copies of the diagrams, and obtain the results calculated from Von Altenech's dynamometer. Roughly speaking, according to diagrams taken before the official trials commenced, the best machine appears to generate a current of 35 webers through a resistance of an average of 2·42 ohms, including that of the arc, with a gross horse-power of 6·64 indicated, made up thus: Engine friction, 1·98 horse power; dynamometer, ·92 horse power; horse-power used by Gramme, 3·74, roughly. Mr. Crompton and Mr. Shoolbred took some diagrams the morning before the official trial. The same machine—*i. e.*, the Mignon Rouart—gave a current of 35·07 meters, through a fixed resistance made up of German silver wire. The resistance of the circuit was then—machine bobbin, brush to brush, 0·414 ohm; field magnet coils, 0·663 ohm; German silver coil, No. 10 B.W.G., 110 ft. in length, 1·43 ohms. Total of circuit, 2·510 ohms. The gross indicated horse power was 6·64, made up thus: Engine from frictional diagram, 1.98 horse power; dynamometer, 0·92 horse power; power used in overcoming mechanical friction of the dynamo-journals, air, friction brushes, etc., 0·47 horse power; power taken in producing current, 3·27 horse power. Both Mr. Crompton and the Anglo-American Company protested against horizontal measurements only being made, but the difficulty in procuring a mirror to reflect the light thrown down an angle of 45 deg. led to the abandonment of that measurement.

At the football match the week before last, the display of light over the area illuminated was very great, probably greater than ever before exhibited. The Anglo-American Company had ten of what it calls 2,000-candle lights, suspended about 18 ft. from the ground, divided on the two larger sides of the rectangle—which was about 180 yards long by 84 yards broad. At the upper end over one goal was one of Mr. Crompton's lights raised to 38 ft. from the ground, and on one side of the rectangle, standing back about 15 yards, was another of these lights raised 55 ft. from the ground. At the opposite end were two Lontin lights placed low and backed by reflectors. These were so great a nuisance to the players, dazzling their eyes, that they had to be lifted up so that their rays hardly reached the ground at all. From roughly measuring by equal shadows it was found that the light of each of the Brush lights, inclosed as they were in ground glass shades, was to the Crompton lights inclosed in clear glass shades as 1 is to 11·5.

It was impossible for the reason above given to measure the Lontin lights. After the match and after the Brush and Lontin lights had been extinguished, Mr. Crompton kept his two large lights burning; and the difference made by the extinction of the other twelve lights was comparatively very small; indeed on all but a small portion of the ground, at the opposite corner to that in which the large lights were placed, the game could have been as well played by the two lights as by the fourteen.

The trials of the well-made and finished engine built by Messrs. Marshall, Sons & Co., of Gainsbrough, for Mr. Crompton have been unavoidably postponed until next week. The jurors appointed to try these motors had provided a Prony brake of a particular nature. Apparently a very large tie beam from a heavily timbered roof had been borrowed and roughly hewn out for the purpose, Mr. Crompton objecting strongly to this primitive affair. The trials are now to be carried on with Professor James Thomson's new "ergometer."—*The Engineer.*

GLUCOSE.*

Glucose is from a Greek word signifying "sweet," and, generally speaking, is the sugar or sweet product that comes from fruits, grain, peas, beans, potatoes, or anything else that will make starch. It differs from the product of sugar cane, the maple tree, and beet-roots, in the fact that glucose will not crystallize or granulate, at least not readily. Chemically speaking, the glucose of commerce, the manufacture of which this paper is to consider, is the same as that which comes from grapes, and is seen on the outside of raisins, etc., and from this the solid glucose takes its name of grape sugar. The grape sugar of commerce, therefore, is glucose in solid form, while the product in the liquid form is also called glucose sirup, though in England and continental Europe, I believe, it is called dextrine or starch sirup.

All the glucose of Europe, except that of Hungary, I believe, is made from potatoes, because they are cheaper, but in this country corn is used exclusively, I think; the process of making from potatoes is similar, however, starch being first made and then converted into glucose.

THE AMERICAN MANUFACTURE OF CORN GLUCOSE.

Glucose was first made here in 1867, on Long Island, near New York city; other manufactories were built elsewhere, but the manufacture was not a commercial success until 1875, when the business appears to have taken a new life, process being improved, whereby the product was made much better and cheaper, and the demand increased very largely.

We now have in operation in the United States, I believe, besides the one lately burned at Chicago, fifteen factories, as follows: three at Buffalo, two at Chicago, and one at each, Davenport and Des Moines, Iowa; Danville, Freeport, Sagetown, and East St. Louis, Illinois; Glen Cove, Long Island; Hudson, New York; Philadelphia, and Leavenworth, Kansas. making about the enormous quantity of 180,000 tons, or 330,000,000 pounds per annum; all but three or four of these factories having been built within the last four or five years. I know of only one in Canada, that is at Windsor, opposite Detroit. There are also now being built, or I understand are about to be, an enormous one at Chicago, having a capacity for making over 250 tons of glucose per day, and one at each, Amora, Rockford, Geneva, Wilmington, and Bureau Centre, Illinois; Iowa City, Iowa; Tippecanoe, Ohio, and Detroit, so that the present production is likely to be at least doubled within a year, and it is already about one-fifth as much as the estimated total consumption of sugar of all kinds in the United States, which is said to be about forty pounds per head annually for the whole population. Each bushel of corn makes twenty-six to thirty pounds of glucose (sirup or sugar), which brings from two and a half to four cents per pound, three and a half cents being the highest price except for a little extra quality, which is very thick, and brings four cents. The corn is worth at Chicago some forty cents per bushel, and the cost of manufacturing in some exceptional cases is as low as twenty-five cents per bushel, possibly twenty-two cents, while it costs other factories at least forty-five cents. One manufacturer, who commenced a few months ago, told me for a time it cost him sixty cents for converting each bushel, and thirty cents for the corn. Now he converts for about forty-five cents, and corn costs thirty-two cents, making seventy-seven cents.

He gets twenty-eight pounds of glucose per bushel, and sells it at two and three-quarter cents a pound, making exactly cost, with nothing for the wear or waste of the factory, interest on capital, risk, etc., etc.

Some of the largest, most experienced, and best conducted factories make, perhaps, forty to fifty cents profit on each bushel of corn worked, getting, say, thirty pounds of glucose, which sells at three and a half cents per pound, the corn costing, say, forty cents and twenty-five cents for converting. This would be $400 or $500 per day profit for a factory working 1,000 bushels per day; but such a factory requires an investment, I think, of about $200,000. The smallest factory now in operation in this country uses about three hundred bushels of corn per day, and the largest 10,000 to 12,000, the others ranging from about 1,000 to 6,000. It is evident, I think, that glucose factories in this country have increased faster than the number of chemists and experts who thoroughly understand the business have, and none but those who thoroughly understand it can make it with much profit to the manufacturer, or safety to those who eat it, especially after the price has declined still further, as it undoubtedly will from the great increase of production.

* From a paper by A. P. Redfield, read at the eleventh annual meeting of the Fire Underwriters Association of the Northwest.

THE CONVERSIONS—STARCH, DEXTRINE, COMPLETE GLUCOSE.

The process is one requiring much skill, and close, careful attention, and success depends almost entirely on one man, the chemist in each factory. The corn, after being shelled, is carried into large tubs and soaked in hot water from thirty-six hours to four or five days if it is not fermented, or six or seven days if it is, the time depending on the hardness of the corn. If fermentation is not wished, the water is changed when it begins to sour; it is then ground, while wet, with the ordinary burr-stones, and with a stream of water running into the hopper with the corn. The "chop" is then run on vibratory sieves, made of fine silk bolting cloth, with other streams of water added; the finer, starchy part of the corn is washed through the sieves, while the hull, gluten, and wooden fiber goes over the tail of the sieves, and after having had the water squeezed from it by rollers, is sold for feed, while wet; the water squeezed from the tailings again going on the sieves. At Buffalo, a small portion of these tailings are kiln dried, so that they can be stored and kept or shipped for feed; but this is not generally done. The portion that went through the sieves is then run into tanks or tubs, and settled; the water is then drawn off, and the sediment again mixed with clean water and treated with alkali, about one pound of caustic soda for each bushel of corn, being made, more or less, according to the "hardness" of the water; this is done to separate any trace of gluten from the starchy matter.

It is then run into long metal-lined troughs or vats, about eight inches deep, from fifteen to thirty-six inches wide, and, if the building is large enough, one hundred to one hundred and fifty feet long; these descend slightly, and most of the water runs off at the lower end, leaving the sediment at the bottom. In some factories the starch-water goes direct from the sieves into these metal-lined troughs, or "tables," as they are usually called. The sediment is left to settle and dry somewhat in these troughs, and is then shoveled out, and known as "green starch," being a solid, but quite wet, about fifty per cent. of it being water.

Up to this point the process is the same as starch making, but afterwards differs.

Starch makers take this green starch and wash it, some of them several times, by mixing it with clean water and again allowing it to settle, then drawing off the water, and repeating the process. It is then refined or bleached, in some factories by chloride of lime or fumes of sulphur, but others depend on washing entirely. It is then settled into a solid, but wet state, made into blocks or cakes about eight inches square, and put into a kiln or dry room and dried for a while, when it is taken out and about half an inch of each side of the cake shaved off, the rest of the block being then wrapped in paper, put back into the kiln, and dried until it forms into little sticks or granules, if fine starch is wanted, or into larger pieces for lump starch.

For glucose, however, this green starch is mixed again with clean water, and made quite thin, when it is run into "converters," though it is usually "washed" and settled several times first. The converters are large wooden tubs or tanks, where it is treated with acids, sulphuric being mostly used, though muriatic, nitric, and even oxalic are used somewhat also. While being thus treated with acids to convert the starch into glucose, it is brought to a boiling point by steam pipes coiled inside the tub and perforated, or by other steam jets. Some use "pressure converters," which are iron tanks like a boiler, where the conversion is quicker, being inclosed and under a steam pressure. The operator makes frequent chemical tests to determine when the conversion is complete, and when satisfactory the mixture is withdrawn into another vat or tub, where the acid is neutralized by putting marble dust, chalk, or fine whiting, or other forms of carbonate of lime or other alkali, for which the acid has a great affinity.

Some of the smaller factories, however, neutralize the acids in the converting tub. It is sometimes then bleached in these converters, or in other tubs, by fumes of sulphur first passed through water, the sulphur being burned in a small iron furnace; these fumes of sulphur are also used in cleaning and sweetening tubs, etc.

The "mixture" is now thin glucose liquor or sirup, but is somewhat discolored, and to clear it of impurities, sulphate of lime, excess of carbonate of lime, etc., and to whiten and cleanse it, it is run through "bag filters" of cloth or canvas, then through filters of bone charcoal, sometimes two or three times, these filters being iron tanks about thirty inches in diameter and eight or ten feet long, filled with the charcoal.

The sirup is then drawn into the "vacuum pan," which is a large, strong tank, or kettle, of iron or copper, with steam pipes coiled inside for heating, and from which the air is exhausted, or nearly so, by an air pump; it is here "boiled down." The boiling in the vacuum is in order that less heat may be used for the evaporating of the water from the sirup, boiling in the open air requiring two hundred and twelve degrees of heat, while in the vacuum it requires only one hundred degrees to one hundred and twenty-five degrees, according to the nearness of the vacuum. Boiling at this low temperature is an economy of fuel, but it is done mainly to keep the sirup as light-colored as possible, the higher degree of heat browning it somewhat. After coming from this vacuum pan it is put through a "press filter" (sheets of metal with cloth between), and sometimes through bag filters, and bone charcoal filters again.

For making grape sugar the treatment is slightly different in conversion, the conversion being carried somewhat further, and when it comes from the vacuum-pan or press or bag filters afterwards, it is left to harden into sugar.

The bone charcoal in the filters soon gets impregnated with a trace of lime, which may be left in the sirup, or other impurities, and must be cleaned and restored. This is done by straining, washing, and cleaning with muriatic acid and water, when it is put into kilns containing retorts and heated till red hot, though some factories do not heat the charcoal quite so hot. From the bottom of the retorts it passes down into sheet-iron pipes called coolers, from six to ten feet long. These coolers, retorts, and the hoppers above them are kept constantly full of the bone charcoal, the charcoal being put into the hopper above as fast as it is drawn from the cooler below, and the fire is usually kept up constantly, night and day, except for repairs.

After having been reburned, the charcoal is sifted to remove the dust, when it is ready for duty again in the filters. In order to supply the wear and waste, new charcoal is added to the old constantly. This charcoal is carried from one place to another by elevators and conveyers.

DEPRECIATION OF A GLUCOSE FACTORY.

There is great waste and wear of building, fixtures, apparatus and machinery. A gentleman, at least as well qualified to speak on that subject as any in the United States, told me, a few weeks ago, that this waste and wear was enormous, and, as an instance, told me that they had put solid oak timber into their factory and been obliged to replace them in eighteen months, because they had rotted away, the peculiar processes and materials used evidently being the cause, and for this reason almost constant repairs are needed. Another manufacturer told me that the cost of repairs and replacement of buildings, fixtures, and machinery, was at least twenty per cent. of the first cost per annum.

THE FIRE RISK OF GLUCOSE FACTORIES AND MANUFACTURES.

As to the moral hazard, there are some exceptions to the general prosperity of the business since 18 6. The highest degree of incendiary hazard outside of the moral hazard arises from the odor of the starch making, the establishment thereby possibly becoming a public nuisance. The glucose factory is, however, no worse in this respect than the starch factory.

The buildings of some of the factories are grand in dimensions, and bad risks in proportion to their grandeur. A fire, well started in a room 150 by 200 feet, or one-half—even one-half—of that size, with a draught made by windows, open elevators, and stairways, would probably defy the extinguishing power of any fire department in the world; and when we have eight of these rooms one above the other, with open elevators, stairways, etc., if a fire is not discovered very early and put out during the first five or ten minutes, or before the building is fairly on fire, say "Good by."

Most of these large buildings have the steam boilers, which are numerous and immense in size, in the main building, though they are generally safely arranged and the apartment light and roomy. Some of the buildings, which are not objectionable on account of the large area of the rooms or height of the building, were put up for other purposes, and are badly crowded and dark, where they should be roomy and light, especially about the boilers and kilns. This is true also of some large factories that were built for the purpose, but have been many times enlarged and added to. This constantly enlarging, changing, rebuilding, and repairing seems to be the normal condition of nearly all the factories I have visited, though they continue operations meantime; and so we have some builders' risks added to the rest.

Most of the large factories shell no corn, but buy it already shelled. The shellers, I think, are one of the greatest hazards in the factory that uses them. They are worse than power shellers in elevators and flour mills, because they run all the time, while in the latter only occasionally, and the refuse and dirt is then cleared up. If corn is shelled, it should be in a building so far away that it cannot possibly endanger the factory, or a round addition should be made to the rate.

As kilns containing retorts are used in all factories, I believe I should count them, and the handling and the storage of the bone charcoal after its burning, the chief physical hazard. The kiln ought to be outside of the main building, entirely cut off or detached, and wherever they are they and their surroundings should be entirely of brick, stone, iron, or other non-combustible material. They are more dangerous than malt kilns to their surroundings, the heat is much greater, the retorts and the bone in them generally being heated to a red and sometimes almost to a white heat. Look out for the hearth or platform in front of the mouth of the kiln furnace. It is often of wood and connects with other woodwork.

The handling and the storage of the bone charcoal after it comes from the retorts or coolers till it goes into the iron filters is another one of the principal dangers. It is supposed to be cooled before being drawn from the coolers, but you will find nearly all of it too hot to bear in your hand, even in small quantity, and I have seen sparks of fire and red-hot coals running out. It then goes into a pile or bin, and spontaneous combustion may take place even when cool, if drawn. No wood should ever be allowed to come into contact with it. It should be stored on a brick or earth floor or in a heavy iron tank (with no wood under it or in contact), and the elevators, conveyers, wheelbarrows, and boxes for sifting and separating it should be entirely of iron.

Bone charcoal elevators should be made so that there should be no danger from friction.

I found a centrifugal wringing machine (which makes 1,200 revolutions per minute) in one factory, where it is used for wringing out the "bag filters" after washing, the journals of which, owing probably to a weak foundation, had created so much friction as to make it dangerously hot, and the superintendent was just taking it out to refit and put on a more solid foundation.

Kerosene lamps, some of them in warm places, are used largely and add nothing to the security, especially as the factories are always run at night, though, I think, 175° fire-test oil is generally used. It should be 300° fire test, especially in the warmest places, or something safer substituted.

Sulphuric acid, muriatic acid, and caustic soda are used largely, some factories using as much as five tons of the former and nearly as much of the latter per day, about one pound of each being used to each bushel of corn worked. Nitric acid and oxalic acid are also used somewhat, as I have said previously, and carbonate of lime (chalk, marble dust, or whiting) largely. These are not very combustible, and most acids alone extinguish fires, but in combination with other substances make very hot and sometimes explosive conditions and gases that are inflammable. These combinations are not very likely to take place in glucose factories, I think, though it might be possible through some accident or blundering employe. For instance, dry starch combined with nitric acid makes an explosive compound similar to gun-cotton, but wet starch or largely diluted acid will not. Sulphuric acid* and turpentine combined explodes or bursts into flame, or both; sulphuric acid and water, muriatic acid and zinc, and almost any acid in contact with almost every metal, creates heat, though, I think, never sufficient to set wood on fire, while dilute sulphuric acid and marble dust makes carbonic acid gas a fire-extinguisher. In burning these acids, however, they may make fumes which cannot be breathed by firemen and others with safety.

GLUCOSE FACTORY FIRES AND IGNITIONS.

The Davenport factory, I understand, was burned from the corn sheller, which, though in a separate building, was near enough to burn the factory; the one at Vincennes pro-

* Sulphuric acid and nitric acid combined generally convert sugars into products analogous to gun cotton.—*American Exchange and Review.*

bably from a spark of a locomotive falling into the chaff and combustible material in the corn-sheller building. This was also a separate building, but *detached* only in the sense of being separate. The one lately burned at Chicago is supposed, I believe, to have died from the lighting too late in the day of a watchman's kerosene lamp.

One of the pioneers in the business—who had just taken the kiln out of the main building of a large factory and put it in a separate building adjoining, but cut off and containing scarcely any woodwork, because he considered it dangerous, though entirely of brick and iron—showed me where the timbers against which the kiln was built were considerably charred, and told me if he was an insurance company he would not insure a glucose factory with kiln in the main building if it had any woodwork near it.

One of the largest factories had an incipient fire from putting some bone charcoal into a wood hopper after it had been kept in an iron tank for thirty hours after being drawn from the coolers. Fortunately it was discovered early and put out; but that factory, and two others, at least, being the largest in the country, now have iron hoppers, storage tanks, sifting boxes, elevators, conveyers, and wheelbarrows, allowing no wood in contact with the charcoal. In another factory the superintendent told me they had an incipient fire in the bone charcoal elevator, which was then of wood, but now all iron.

The chemist of another factory told me he saw a large pile of bone charcoal on a brick floor in a sugar cane refinery, which had then been out of the coolers three weeks, found to be red hot six or eight inches below the surface.

THE HIRSH PROCESS.

By ADOLF H. HIRSH, of Chicago, Ill.

IMPROVEMENT IN THE MANUFACTURE OF SUGAR FROM CORN.—PATENTED OCTOBER 16, 1866.

IN the first place I take about five thousand pounds of Indian corn or maize, or other cereals containing starch, and soak it in a suitable tank or vat in highly diluted sulphuric acid at an elevated temperature until the grain becomes soft.

The diluted acid I prepare in such proportions as to mix one quarter or one-half pound of the commercial acid with one hundred pounds of water. Of this diluted acid I put enough into the tank mentioned above to cover the grain contained therein. I then heat the mass by the aid of steam to a temperature of not exceeding 170° Fah. The steam I apply by means of a mashing-machine, as used in distilleries or breweries, and consisting of steam pipes which are constantly revolving by means of appropriate cog-wheels and stuffing boxes to prevent leakage. Thereby I gain a uniform mixture and an equalization of heat in the mass of acid and grain.

In the absence of a mashing apparatus, I apply the steam directly or through a coil under a false bottom in the vat containing the grain and acid, whereby I prevent the contact of the steam with the grain itself, which, by the high temperature of the former, might be made pasty, and then be spoiled for the present purpose of preserving the starch in its raw unchanged state.

The elevated temperature of the mixture accelerates the softening of the grain, which is permeated by the diluted sulphuric acid. The latter, coming into intimate contact with the gluten of the grain, unites with it to an insoluble spongy compound the sulpho-proteic acid, which is easily removed at a subsequent period of the process, to be described hereinafter. This step in the preparation of the starch from the corn differs materially from the old processes found described.

The old mode of extracting the starch from the corn consists in soaking the corn in cold water, or in water heated only a few degrees above the normal temperature—never above 70° Fahrenheit, and that in winter only. This softens the grain but slowly, eight to fifteen days being requisite for the purpose, while the much greater heat at which I apply the diluted acid produces the softening of the grain in less than half the usual time. On softening of the husk according to the old slow method the gluten frequently putrefies, (always in summer), causing an unpleasant, unhealthy odor of sulphureted hydrogen, which is increased, if, as some manufacturers do, alkali is added to the water covering the grain.

The chemicals I use in this process are never used by others at this stage of the same, nor at any stage for this purpose. Sulphuric acid is generally used at the subsequent process of converting the starch into sugar; but for the removal of the gluten in the insoluble state of sulpho-proteic acid it never has been employed, the old manner in use now being the treatment with caustic soda, which dissolves the gluten, but only after repeated applications, occupying three weeks' time in our best starch factories. This tedious and expensive use of alkali I discard entirely.

Within two or three days after the application of the acid the corn or other grain is soft enough for grinding, which I perform accordingly in suitable mills of stone or iron, or between rollers. This crushed mass of maize or other grain I pass through suitable sieves, which retain the husks, while a milky substance, consisting of starch, water, sulpho-proteic acid, and finely ground husks passes through the meshes and run upon a broad inclined plane (gutter), having an incline of one inch to every twenty feet of length, and which is two or three hundred feet long.

If the room at command does not permit the use of gutters of that length, they may be constructed in short sections placed above each other.

Upon this inclined plane or planes the starch is deposited by its great specific gravity, while the water, the light sulpho-proteic acid, and finely-ground husks that had passed through the sieve float off, and may be used with the husks as cattle-feed.

The starch left upon this inclined plane I place into suitable vats, where I wash it with water containing one per cent. of spirits of ammonia. This will dissolve any gluten that may not have been reached by the former treatment with acid. As soon as the starch has subsided to the bottom of the vat in which I wash it, I withdraw the ammoniacal solution of gluten from the top, and wash the starch with pure water once or twice, until all alkaline reaction is removed.

The presence of alkali I consider positively injurious to my process, as the alkali would not only cause an unnecessary expense of acid by partly neutralizing the same, but the sulphate formed would also, by its presence in the sirup, give it an unpleasant taste.

The starch remains in great purity at the bottom of the tank. It differs from commercial starch by containing no trace of gluten, nor even a slight alkaline reaction, either of which is present in all commercial starch, according to its preparation with alkali or without chemicals; and it is this superior purity of the starch prepared according to my mode, described just now, over other starch made from cereals which I claim as a superior result of my improved process.

The starch in its present state also differs from commercial starch in the water it contains, which in the latter is removed in the subsequent drying process. This constitutes the first degree or first manipulation in my process.

Second Manipulation.—I now have prepared and ready for use another vat or tank, made of wood, or made of iron lined with lead to prevent corrosion. The tank contains a mashing-machine, as used in the first stage of my process, consisting of appropriate cog-wheels, steam-pipe, and stuffing-boxes, so as to keep, by the motion of the apparatus, the contents (to be described hereinafter) in constant motion, which accelerates the chemical process by bringing chemicals and the starchy part into more frequent and more intimate contact.

In the absence of a mashing apparatus, I make the discharge-openings for the steam very small, so as to insure pressure, and by the same constant motion in the boiling liquid. In both cases I use direct steam in the liquid in preference to the use of the coil, as I thereby insure a more economical use of the steam as a source of heat, as well as that of a motive power, by keeping the boiling mass in commotion. Into this tank I place about five hundred pounds of water, and admit steam through the appropriate stop cocks, causing the water in the tank to boil. Then I pour into it about eighty pounds of sulphuric acid, about five pounds of the sulphate of alumina, and about fifteen pounds of finely-powered coke or vegetable charcoal.

This joint use of the alumina and charcoal for the production of a pure saccharine solution I claim to be an improvement over the old methods, which, dispensing with the alumina, required a longer time for the clarification of the sweet liquid by rest, the light porous particles of charcoal floating persistently in the dense liquid, while they would pass through any bag-filter that would permit the percolation of the saccharine liquid with anything like practical rapidity.

The flocculent alumina on the other hand envelops, as mentioned before, the charcoal and other impurities, and by its great specific gravity carries them with itself to the bottom, leaving the saccharine liquid soon in a limpid state, when it requires either no filtration, or, upon filtration, passes through the filtering medium with great rapidity, acquiring superior brightness.

I well take care not to add the acid before the water has attained the boiling-point, as the long contact of the same with the wood alone would gradually convert it into humus, which, increasing by the long continuance of such a practice, injures the taste of the sirup, rendering the same what is termed "clayey."

As soon as the chemicals are mixed with the boiling water I admit the starch, as prepared in the first degree of my process, after having mixed the same with sufficient water to give it the consistency of cream, taking well care that the volume of this cream added to the volume of the boiling water in the vat fills only two-thirds of the latter, so as to leave sufficient space for the water accumulating afterward from the condensation of the steam.

I admit the starch in its creamy consistency in several small streams into the boiling mixture of water and chemicals, which are constantly kept in motion by the mashing apparatus or the vehement afflux of steam, and keep the mixture boiling for the space of from two to six hours, according to the pressure of the steam used in treating the liquid, the time for boiling being shortened with the increase of pressure and temperature.

I boil the liquid until the starch is completely saccharified. As soon as this has taken place I shut off the steam and add freshly-slaked lime stirred up in water to the consistency of milk until the liquid reddens litmus but slightly, when I add common chalk until all effervescence ceases. For the above proportions of acid I use about eighty pounds of lime and ten of chalk. By these means no free caustic lime remains in the liquid, so as to deteriorate it, as would be the case if the neutralization were completed with quick-lime, which might render the sirup bitter.

The sulphate of alumina which I prepare in the usual mode, becomes also decomposed by the lime and chalk, which appropriate the sulphuric acid, while the hydrate of alumina in its nascent flocculent state facilitates the precipitation of the gypsum and of other impurities collected and absorbed by the charcoal or coke, replacing in its action blood, which is used in the old process of defecation. The use of charcoal or coke I consider the best; but it may also be replaced by animal charcoal, in which case I soak the same for twenty-four hours prior to using it in muriatic acid containing six per cent. of the concentrated acid, and remove again the acid completely by washing the charcoal with pure water.

The manner of using the charcoal, *i. e.*, its presence during the entire process of saccharification—will render its use more efficacious than its application for only a few minutes, as indicated in the patent of Goessling, where it is introduced only at or about the time of neutralization, and is soon again removed. Every chemical process requires time, and especially that of absorption, which in the manner proposed by me at present is more complete than in others in use heretofore in the manufacture of corn-sugar, the charcoal absorbing here any impurities like newly formed humus, etc., as fast as it is produced, and preventing its accumulation.

After the addition of the chalk I take care not to heat the liquid anew, so as to avoid the deleterious action which lime exerts upon sirup at a higher temperature. I then pass the liquid through a bag-filter, which permits only the clear saccharine liquid to pass, while it retains the precipitated salts of lime and the alumina and charcoal, or equivalent. This residue may be entirely freed from any saccharine liquid by steaming and pressure.

The long continued action of the charcoal, combined with the purifying action of the alumina, removes all foreign substances so completely that the filtered liquid will contain but pure sugar.

This completes the second manipulation of my process.

Third Manipulation.—The third manipulation of my process divides into two different branches, according to the object in view of producing sirup or sugar.

For the latter purpose I placed the saccharine liquid, as prepared in the second manipulation of my process, immediately into a vacuum pan, adding again about ten pounds of charcoal, coke, or bone-black (powdered), and evaporated to the consistency of 35° on Baumé's saccharometer.

As mentioned in the second degree of my process, here again the constant presence of charcoal or equivalent is an improvement upon former methods, the charcoal absorbing any products of the decomposition of sugar that may be formed by the action of heat, and of a minute quantity of gypsum held in solution, as fast as they are formed, preserving the sugar in such purity as will favor best its crystallization.

I then pass the sirup hot through a bone-black filter, allowing the liquid to enter the filter at its bottom, and to rise by hydrostatic pressure to the top, where the sirup runs off clear, transparent, and limpid, while the pores of the filter retain the powdered bone-black, or equivalent, and gypsum previously held in solution by the sirup. The latter I then run into moulds, where the sugar will crystallize within a few days, when I treat it like ordinary sugar.

For the second branch of the third manipulation—the manufacture of sirup—I use an open flat pan or evaporator, in which the saccharine liquid passes in a stratum one inch high, running in and out continually, while steam or direct fire is the heating medium. The saccharine liquid here gets heated to over 140° Fahrenheit, and the sugar naturally gets changed into uncrystallizable sugar, glucose, or fructose of the composition $C_{12}H_{12}O_{12}$. This decomposition does not need to take place completely, as the glucose will prevent the crystallization of an equal weight of crystallizable sugar.

The old method of preparing starch sirup (which will preserve its liquid state) consisted in carrying the saccharification only to such a degree that about one-half of the starch remained unconverted, or was converted only into gum-dextrine, which prevented the crystallization of the sugar contained in the sirup; or a certain quantity of such gum sirup was added to the saccharine solution, as in the Goessling patent.

The method proposed by me now converts grape-sugar into fruit-sugar, which although not capable of crystallization, while it prevents the crystallization of its own weight of sugar, still adds to the sweetness of the sirup, which is not the case with dextrine or gum-dextrine, the latter diluting the saccharine solution, and thereby diminishing its relative sweetness.

The resulting sirup resembles maple sirup very closely, as well as the sugar, which, by the purifying action of the charcoal during evaporation, is rendered exceedingly pure, and resembles maple-sugar.

This completes the third and last manipulation of my process, which produces, upon an average, twenty-five pounds of sugar resembling maple-sugar, or about thirty pounds of maple like sirup, from one bushel of Indian corn or maize.

When other cereals are subjected to this process in place of maize, they should be used in such quantities that the amount of starch contained therein equals (about) the quantity of starch contained in maize, having reference to relative proportion of grain and chemicals.

(*To be continued.*)

TIME IN THE FORMATION OF SALTS.

By M. BERTHELOT.

THE part played by time in chemical reactions was formerly overlooked, or ascribed to the want of contact and of homogeneity, and in any case regarded as of little importance. It was especially brought under the notice of chemists in consequence of the author's researches (1854) on the synthesis of neutral fatty bodies and of polyatomic ethers, resulting from the union of acids and saccharine principles, compounds formed simply by the prolonged contact of the reacting bodies. These and subsequent researches show the distinction which exists between ethereal reactions, slow and progressive, even in homogeneous systems, and the saline reactions, the duration of which is so short in the majority of cases that it escapes our present means of measurement. Whenever an acid dissolved in water is caused to act upon a dissolved base or salt, or a dissolved base upon a dissolved acid or salt, or two dissolved salts the one upon the other, whenever the resulting products are equally soluble and form a homogeneous system, the reaction does not in general require for its completion any appreciable interval of time further than is necessary to effect the exact mixture of the two liquids. The author shows how slow chemical changes may be detected and measured by thermic methods. The chemical equilibrium so rapidly established in dissolved saline systems seems correlative with the electrolytic conductibility which characterizes such systems.

AN OLD CAN OF PRESERVED MEAT.

By G. W. WIGNER, F.C.S., etc.

DURING the recent International Food Exhibition, Mr. Leonard Wallington brought under notice of the judges a remarkable tin of preserved meat. This tin had been in Mr. Wallington's possession for twenty-nine years, and was, he supposed, some five or six years old when he received it. It was tinned (as appeared by the stamp on the tin) by D. Hogarth & Co. The tin was of what we should consider now to be unusual thickness. It had apparently been painted outside with an oxide paint; but, notwithstanding this, the exterior of the tin had corroded so much that in dusting it carefully two small scales were displaced, which left pin holes in the metal.

It was not convenient to open the tin for five or six days after this, and the contents began to smell. No odor had been perceptible in the first instance. When the tin was cut open, and the contents emptied in the form of a solid lump, two patches of decomposed meat were seen, each about 1½ inch by ¾ inch, spreading from the two pin holes. The rest of the meat was sound, and, after the removal of the decomposed patches, appeared to be in excellent condition. It was tainted, but it was clear that was due to the odor from the decomposed patches, for, when washed, all taint was removed.

The contents consisted of veal, with a large proportion of fat, and a few peas. The fat appeared to be entirely the natural fat of the meat.

The meat was analyzed, and gave only 0·68 per cent. of ash. This ash was free from lead, but contained minute traces of tin. The quantity was far too small to estimate quantitatively. It was unquestionably less than the proportion usually present in tinned goods one year old. The salt was also low, and this may have something to do with the absence of tin. Only 0·09 per cent. was found. This looks as if the veal had been boiled, and the liquor decanted before canning.

The most important result was that lead was absent. There has not been time enough to assay the metal of the can; but it seems pretty well evident that it was really tinned iron plate, and not Terne plate, containing lead.

Thirty odd years is a long test for tinned meat; and it is remarkable that any portion of it should have been quite free from decomposition after that time. Such a successful result may possibly lead to the use of better and sounder tins than those now in vogue.—*The Analyst.*

CHEMISTRY FOR AMATEURS.

THE most distinguished chemists have not thought it beneath their dignity to employ the simplest means of investigation. Scheele, for instance, made some of his most brilliant discoveries with very simple apparatus, devised from such common objects as he happened to have at hand. Those of our readers who desire to repeat some of the experiments illustrative of the fundamental truths of chemistry may not be loth to have pointed out a similar means of performing them. It will be the object, then, of the present article and a few subsequent ones to show how this object may be accomplished, by the addition of a few test tubes and a spirit lamp, to a list of chemical apparatus which may be found in every house. Besides these, the amateur will need a few simple chemicals, from which he can manufacture for himself various salts, etc. Nothing further is needed; aided by ingenuity and perseverance, he will then be in a position to form for himself a chemical laboratory, both cheap and effective.

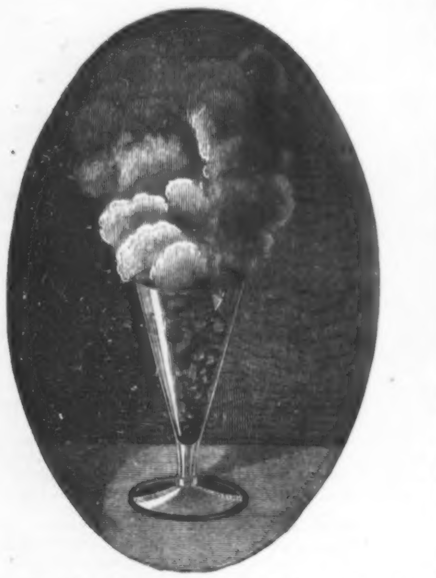


FIG. 1.—REACTION BETWEEN NITRIC ACID AND IRON.

If it be desired to show with what energy bodies combine, and how chemical reactions take place, it is only necessary to place some iron nails in a glass, and to pour over them some nitric acid or aqua fortis. Immediately a brisk effervescence will ensue, clouds of a yellowish red vapor will be evolved having a suffocating odor, and the temperature will rise to such a point that the hand can scarcely bear the heat of the glass. (See Fig. 1.) In this case the nitric acid exerts a double action; it first oxidizes the iron, and then combines with the oxide thus produced to form a *salt*—nitrate of iron. The same thing occurs with all other metals which are soluble in nitric acid; as, for example, with silver, copper, lead, mercury, etc. This example of chemical *combination* may suffice to illustrate the subject without dwelling further on other experiments belonging to the same category. We will publish at the present time a description of some chemical experiments which are of such a nature that they may be readily repeated, and which will interest all amateurs of the science. We will begin by showing how those curious *Pharaoh's serpents* may be made, which had such a celebrity a few years ago. The little combustible cones, which give rise to the curious serpent-like object, are prepared from sulphocyanide of mercury. To obtain the latter product it is necessary to dissolve sulphocyanide of potassium in a dilute solution of acid nitrate of mercury, when there will form a copious white precipitate. This is collected on a filter and washed with water, and afterwards dried at a temperature of 100°C. In a dried state it is a white powder. This is then to be made into a firm paste with a little gum-water. A small quantity of powdered nitrate of potash having been added, the paste is formed into small cones, dried in a water bath, and covered with tin foil. Once perfectly dry, the *egg* thus formed is ready to hatch; and, on the application of a lighted match to the apex of the cone, the phenomenon at once takes place. The sulphocyanide begins gradually to swell, and there immediately begins issuing forth a thick, serpent-like coil which continues twisting and increasing in length to an almost incredible extent. (Fig. 2.) The quantity of matter thus produced is truly marvelous, especially as the coil which so exudes is solid and may be handled, although, of course, it is extremely light and somewhat fragile. The product thus formed is in part composed of cyanide of mercury and paracyanogen; and, being very poisonous, should be thrown away or burned after the experiment. During the decomposition of the sulphocyanide of mercury copious fumes of sulphurous acid and other gases are given off, and it is to be regretted that "Pharaoh's serpent" makes its presence known by a very disagreeable and suffocating odor. It would be imprudent to perform the experiment several times in the same room without having care to ventilate it well each time.

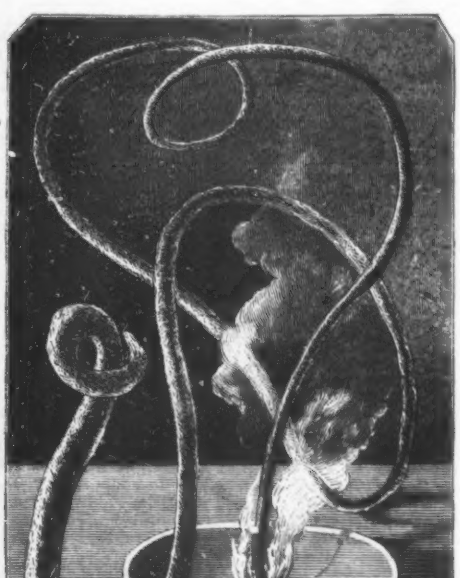


FIG. 2.—EXPERIMENT WITH PHARAOH'S SERPENTS.

FIG. 3.—FORMATION OF CRYSTALS OF IODIDE OF CYANOGEN.

In drug stores there are often seen large glass globes, the inner surface of which is thickly covered with transparent, silky white crystal, of a most elegant appearance, and which are formed above a red powder which covers the bottom of the vessel. These crystals are the result of another combination—that of cyanogen with iodine. The preparation of iodide of cyanogen is very easy. It is a very volatile compound, and has a great tendency to assume a well defined crystalline form. Rub up in a mortar a mixture formed of fifty grains of cyanide of mercury and one hundred grains of iodine, until the powder, which is at first brownish, becomes of a brilliant vermilion red. This is iodide of mercury. The cyanogen of the cyanide of mercury also unites with the iodine, and the result of the combination is transformed into vapors very rapidly. If this red powder be inclosed in a corked glass vessel the fumes of the iodide of cyanogen soon condense and almost immediately give rise to beautiful, white silky crystals, which often attain considerable length. (Fig. 3.)

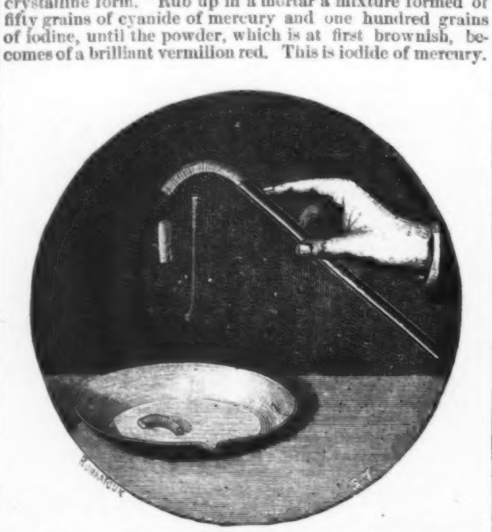


FIG. 4.—EXPERIMENT WITH AMMONIACAL AMALGAM.

Ammoniacal gas, combined with the elements of water, seems to be analogous to a metallic oxide containing a metallic radical—*ammonium*. This compound *hypothetical* metal can, in a measure, be regarded as really existing, since it is possible to amalgamate it with mercury. This gives occasion for a very remarkable experiment, which may be performed as follows: Pour into a porcelain mortar a small quantity of mercury; throw in some bits of sodium and stir the two together with a pestle, when quite a loud crepitation will be heard, attended by heat and light, showing that a combination of the sodium and mercury has taken place. If this fluid amalgam, when cold, be placed in a glass tube, closed at one end, and containing a strong solution of sal ammoniac, the production of an ammoniacal amalgam immediately begins, the mercury becoming quite pasty and increasing so prodigiously in volume that the tube will no longer contain it all. (Fig. 4.) According to the theory above-mentioned, the basylous radical *ammonium* existing in ammoniacal salts has, in this experiment, formed an amalgam with mercury, driving out the sodium, which had first combined with the latter. Left to itself the amalgam quickly decomposes into fluid mercury, ammonia, and hydrogen; and it is quite possible that the so-called amalgam is, after all, nothing more than mercury which has absorbed a certain quantity of these gases.

It is well to bear in mind that, among ammoniacal salts, *phosphate of ammonia* is valuable for the property it possesses of rendering the lightest fabrics incombustible. If muslin or gauze be soaked in a solution of this salt and afterward dried in a current of air it will be found impossible to set the fabric on fire. It may be carbonized, but it cannot be made to burst into flames—even by the most intense heat. It is to be wished that this remarkable property were taken advantage of in the preparation of robes for the ball, which so often are the cause of grave accidents, owing to their light and inflammable nature. But there could be no danger of fire with a dress which had been treated with phosphate of ammonia—a salt which is very little used, and which is sold at a low price by all manufacturing chemists.

FIG. 5.—PYROPHORUS BURNING IN CONTACT WITH THE AIR.

If it be desired to have a cool drink in summer, the ammoniacal salts will afford a means of obtaining it. *Nitrate of ammonia* mixed with its weight of water will produce a depression of temperature of about twenty-four degrees, and may thus be used for easily manufacturing ice. *Volatile alkali*, or "spirit of hartshorn," is a solution of ammoniacal gas in water; and *sal volatile*, the pungent odor of which so quickly restores those who feel faint, is a carbonate of ammonia.

Among the experiments which may be performed with common metals, that with *ferric pyrophorus* is very interesting. To prepare this product, take a tube of green glass, closed at one end and drawn out to a point at the other, and place therein some very dry pulverized oxalate of iron. Heat to redness and pass through it a current of hydrogen gas. Under the combined influence of the latter and the heat the oxalate of iron is reduced to a metallic state in the form of a black impalpable powder. The pointed end of the tube is then closed by the aid of a spirit lamp. Thus protected from the air the pyrophorus will keep indefinitely. But just as soon as the point of the tube is broken off and the powder is shaken out it burns spontaneously, forming a very beautiful rain of fire, as shown in Fig. 5. Another kind of pyrophorus, having similar properties, may be made from lead. Mix a solution of, say, twenty-five grains of sugar of lead with a solution of ten grains of tartaric acid; the white resulting precipitate is collected on a filter, washed and dried, and constitutes insoluble tartrate of lead. Fill a small vial one-third full of this dry lead, salt and heat it in a sand-bath over a spirit lamp as long as fumes escape. These have an empyreumatic odor, and burn with a blue flame, because they contain much carbonic oxide gas, generated by the carbonization of the tartaric acid. But the latter contains so much carbon that a portion of it remains behind, intimately mixed with the metallic lead. The black substance obtained is a pyrophorus, which inflames spontaneously when poured out on any substance, because, on account of its great porosity, it imbibes oxygen eagerly from the air. If the vial is closed while it is yet

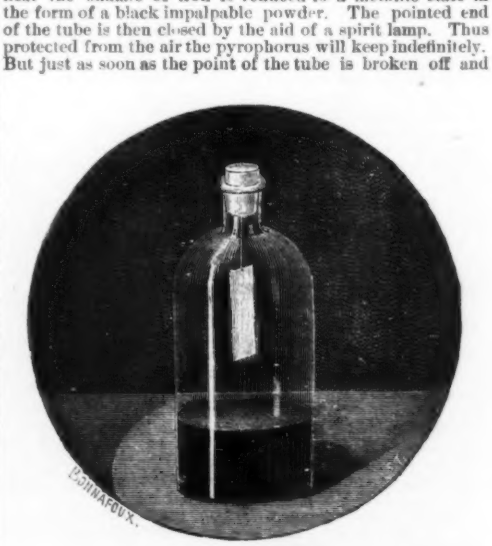


FIG. 6.—GOLD-LEAF SUSPENDED OVER MERCURY.

hot, this pyrophorus will retain its inflammable properties several days.

Mercury volatilizes to a sensible extent at all temperatures above 19° or 20° C.; but below this point its volatility is imperceptible. This curious property of a metal may be shown by the experiment represented in Fig. 6. A piece of goldleaf is suspended an inch or two above a layer of mercury contained in a bottle. Before long the gold leaf will be seen to tarnish and to gradually form an amalgam with the absolutely invisible vapors given off from the mercury.—*La Nature.*

CARBONIC ACID IN THE ATMOSPHERE.

INVESTIGATIONS respecting the quantitative composition of the air have for a long time engaged the attention of scientists. If we look over the annals of science we find that from the time of Lavoisier until the middle of the present century nearly all renowned chemists have taken part in these investigations. The names of a Priestley, Scheele, Cavendish, Saussure, Humboldt, Dalton, Gay-Lussac, Dumas, Bunsen, Leibig, Pettenkofer, and many others of almost equal renown, prove that the necessary attention has always been paid to this most important subject. Therefore it might be assumed that the composition of the atmosphere as well as its eventual changes are perfectly familiar to the scientific world, and that we have an accurate knowledge of the quantitative proportions of the single gases contained in it. Concerning the most important gases, viz., oxygen and hydrogen, this assumption is true. Experiments which have been made with the very best instruments show that the quantitative proportions of these two gases are subjected to a comparatively little change, and that normal air in its dry state contains in a hundred volumes from 20·9 to 21 volumes of oxygen. According to the latest investigations of Jolly,* the differences of the quantity of oxygen contained in the air are, it is true, somewhat greater, and change from 20·4 to 21 per cent.

We are equally well informed regarding the quantity of water contained in the atmosphere, which varies greatly. In order to ascertain these variations, experiments are made daily in the meteorological observatories. But very insufficient is our knowledge regarding the fourth factor contained in the atmosphere, viz., carbonic acid.

Until lately it had been believed that the quantity of carbonic acid in the air varies in a certain determinal manner, and the experiments of Saussure, Verver, and others seem to justify this supposition. In our books of chemistry may be usually found the following sentence: "Atmospheric air contains a small quantity of carbonic acid, which generally varies from 0·004 to 0·006 p. c. in volume."

The latest investigations of J. Reiset,† whose eudiometric discoveries are well known among scientists, now show that the assertion contained in the above mentioned sentence is perfectly incorrect; that atmospheric air has a quantity of carbonic acid which is constant or scarcely varies at all; and that 100,000 volumes of dry air in its normal state contain from 29 to 30 volumes of carbonic acid.

Reiset, in experimenting with large quantities of atmospheric air, has endeavored to eliminate the chief mistake made in earlier investigations. He used for his experiments two transportable aspirators, each having the capacity of 600 liters, which could be easily connected with an absorption apparatus. One of these aspirators was used in a free place far away from human habitations, while with the other experiments were made in such a locality where a difference in the quantity of carbonic acid might have been expected on account of an exuberant vegetation and other causes. Our illustration shows the absorption apparatus which Mr. Reiset used in his experiments.

I is a U-formed tube, which is filled with pumice soaked in concentrated sulphuric acid. In the lower part of this tube is a small glass globe serving the purpose of collecting the diluted sulphuric acid, which else would render difficult the passage of air through the tube. The tube, I, serves as a drying tube, and retains the moisture of the passing air, indicating by its increased weight the quantity of water retained. The dried air passes then through the tube, *t*, into the washing bottle, F, thus entering the absorption vessel proper. This forms the chief part of the apparatus, and its construction is based upon a principle which was employed by Schloesing in absorbing the ammoniac in the air. As the illustration shows, in the glass cylinder, T, there are fastened three capsules of thin platina plate, C, C¹, and C², which have a somewhat conical form. Each of these capsules has a diameter of 4 cm., and contains about 120 small perforations, the width of each perforation being 0·5 mm.

T has the length of 0·5 m. By means of a tightly-fitting caoutchouc ring the cylinder, T, can easily be connected with the washing bottle, F. Before beginning the experiment, 300 cm. of a clear solution of baryta, the strength of which has been previously ascertained by means of volumetric analysis, are brought into the cylinder. The latter is then joined hermetically to the U-formed tube, I I, which has been prepared in exactly the same manner as the tube, I, and the connection of the apparatus with the aspirator is thus formed.

After the experiment was finished, *i. e.*, after 600 liters of air had passed through the apparatus, Reiset found that a solution of baryta in the lower part, B, of the cylinder was perfectly loaded with carbonate, that in the second part, B¹, it had a milky appearance, while in the third part, B², it was entirely clear and pellucid, a proof that a perfect absorption of carbonic acid had taken place. Then the baryta solution was put into a bottle, which could be easily closed, the cylinder and washing bottle were carefully rinsed with known quantities of water, all the liquids were united, and a quantity of water was added, the weight of which corresponded to that by which the weight of the U-formed tube, I I, was increased. Thus was contained a liquid in which, after a complete precipitation of the carbonate of barium, the quantity of the undecomposed baryta could be easily ascertained by adding a measured quantity of the clear solution of baryta, and by a simple calculation a quantity of carbonic acid contained in the examined air was found. [Of course the measured quantity of air had to be reduced by calculation to a temperature of 0° C. and a pressure of 760 mm.]

In this manner Reiset has for six years labored indefatigably to ascertain the amount of the carbonic acid contained in the atmosphere, and by his careful experiments he has obtained the following results:

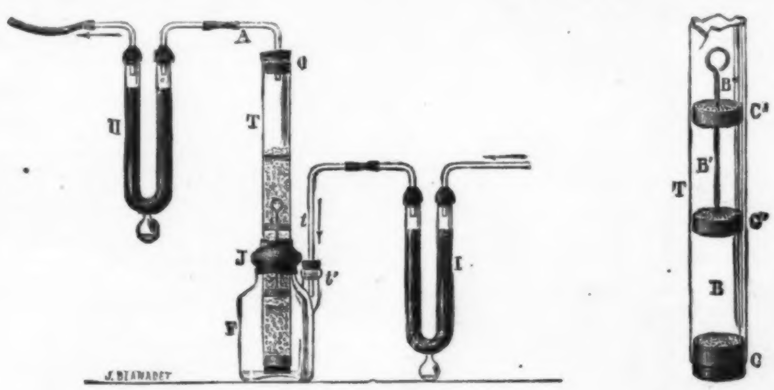
1. The quantity of carbonic acid in the atmosphere is constant. After comparing all the investigations it was found that, in average, 29·78 volumes CO_2 are contained in 100,000 volumes of air.

2. The experiments made in Paris in the month of May of the years 1873, 1875, and 1879, show a somewhat higher amount, in average, 30·27 in 100,000.

3. In comparing the experiments which were made in thickly-leaved forests and in fields exuberant with vegetation with those made in barren localities, it was discovered that the diffusibility of carbonic acid was enormous. Twenty-seven experiments showed that the average amount of carbonic acid contained in the atmosphere of the forest is 29·17 in 100,000 (volumes), while the air in the barren localities showed a yield of 29·02 CO_2 in 100,000 volumes.

4. Night air contains somewhat more carbonic acid (30·84 vol.) than day air (28·91 vol.).

5. An increase of the CO_2 yield was found by Reiset on foggy days. The mean of 12 experiments showed 31·66 vol. CO_2 in 100,000 volumes of air, the maximum on an unusually foggy day in fall being 34·15.



At the conclusion of the valuable and highly interesting record of his labors, Mr. Reiset draws our attention to the fact that the figures found by him prove the equal diffusion of carbonic acid, which was already anticipated by Gay-Lussac, and that notwithstanding the variable amount in which this gas is generated in different localities and added to the air, the diffusion takes place in a minimum of time.

* *Wiedem. Ann.*, 6, 520-544.

† *Comptes Rendus*, t. 88, p. 1007, and t. 90, p. 1144.

ON POTASH FULLING SOAPS.

By W. J. MENZIES.

IN the first place, it cannot be too strongly insisted upon that nothing but a potash soap should be used for washing woolen goods of every description. It is a very great mistake to use a soda soap for such a purpose. Soda renders wool brittle and harsh, and gives it a yellow color. Potash lubricates the fiber, renders it soft and silky, and tends to bleach and whiten wool. It is generally admitted by the best and most intelligent worsted spinners and woolen manufacturers that this is the case—in fact, that it is difficult to spin a fine woolen yarn without the assistance of a good potash soap. This is quite indorsed by nature; when the wool is still on the sheep it is naturally covered with a waxy, oily substance generally called "grease;" this substance is found to consist to the extent of more than half its weight of actual potash combined with animal matter—hardly a trace of soda being present. It is generally found also in the case of plants, that potash is more easily assimilated than soda; hence it is less liable to do injury when used for scouring purposes, also in the case of vegetable as well as animal fibers.

Potash soap, so far, has not been used in this country nearly so extensively as soda soap. There are several reasons for this. In the first place, potash has not been so easily obtained in a pure form, Montreal ashes being the most general kind of potash in use by soapmakers. This article is obtained from the ashes of burnt trees, principally from Canada. They are collected together and mixed with lime, then thoroughly lixiviated in vats, and the resulting lyes boiled down and poured into moulds forming, when cold, solid blocks, which are then packed into barrels. The result is at best a potash containing some twenty per cent. of impurity; the product also is very variable, owing to the different kinds of trees from which these ashes are obtained. They are also often adulterated more or less with soda ash, the inspection of the potashes in Montreal, and division into "firsts," "seconds," and "thirds," being absolutely no guarantee whatever as to their *potash* contents. The inspector simply contents himself with testing their total "alkali" strength with an alkalimeter, and therefore in no way distinguishing between potash and soda. In this way it would be quite possible for a parcel of potashes to be branded as "firsts" in the Montreal warehouse when highly adulterated with soda ash, or even actually containing no *potash* at all.

Another reason why potash "fig" soap has not been much employed is that oil has been generally so much dearer than tallow or grease. Two oils were originally almost exclusively used for soapmaking purposes—fish oil and olive oil. The objection to the first is, that the smell is so very strong and disagreeable as to render such a soap unfit for finishing purposes. As to olive oil, nothing can be better for the purpose; but it is a very expensive article, and cannot be used except for the production of a soap for the very finest purposes. Within the last few years, however, cotton-seed oil has been generally introduced; it is now produced on an enormous scale, and is very well fitted for the manufacture of fulling soap. The refining of this oil during the last few years has been very much improved, so much so, that some of the best refineries now turn out an article that in taste, color, and appearance cannot be distinguished from olive oil. A soap made with this oil is in every way suitable for fulling purposes of all descriptions, and cotton-seed oil being now much cheaper than tallow, the cost of production of a good soft soap is actually less than that of a *pure* hard soap. A third reason against the use of "fig" soap has always been a general idea that because it was *soft* it contained much more water than a soda soap. This is quite a mistake, as it is soft because made with potash, which produces a naturally soft soap, just in the same way that soda produces a naturally hard soap. In fact, in actual practice, taking weight for weight, a good potash soap for scouring and fulling purposes will do more work than a hard soda soap, potash being a superior alkali to soda for such purposes.

The production of a good soft soap has so far been a difficult and delicate operation, requiring large boiling pans and special apparatus for the purpose. Montreal potashes, already mentioned, were taken, dissolved in water, and a weak lye produced. This was agitated with lime and the clear liquor run off; the caustic lye thus obtained was partly used at its normal strength, partly concentrated by boiling for use in the final stage of the soapboiling process, or German carbonate potash was treated in the same manner; this latter article, however, is more difficult to use satisfactorily, owing to its requiring much more lime and labor to render it thoroughly caustic as compared with Montreal potashes. In both cases, the lye thus obtained was full of impurities, and always contained more or less soda. What was much worse, however, this soda was always an "unknown quantity" to the soapboiler, and rendered the formation and production of the soap a difficult operation; the boil, owing to the soda contained in the potash, sometimes unaccountably going wrong, and working altogether differently to what was expected. This soapmaking process has lately been much improved for large soapboilers by the introduction by the Greenbank Alkali Company, of St. Helens, Lancashire, of a pure caustic potash, quite free from soda, thus allowing a perfectly caustic lye to be easily obtained by simply dissolving this article in water. This is, however, by no means the only advantage of this caustic potash, as, being pure and concentrated, a soft soap can be made by consumers themselves without boiling, and in small quantities, by a process very similar to that for producing hard soap with the double-refined powdered caustic soda, as fully explained in the August number of the *Chemical Review*.

The following directions will produce an excellent potash fulling soap for manufacturers' use:

Take 50 pounds of Greenbank pure caustic potash; put it in any metal or earthenware vessel, with 9 gallons (90 pounds) of water. Stir it once or twice; it will dissolve immediately and become quite hot. Let it stand until the lye thus made is cold. Place in any convenient vessel for mixing 22½ gallons of cotton-seed oil. Pour the lye into the oil in a small stream, at the same time stirring with a flat wooden stirrer about three inches broad. Continue gently stirring until the lye and oil are thoroughly combined, and in appearance like honey. Now cover the vessel up and put it in a warm place until the next day. The oil and lye will then be found nearly all combined. Stir up well again, and leave for a few days, when the mixture will become quite even, and the saponification complete; the result being the production of about 345 pounds of very stiff potash soap. If made for use by an actual consumer nothing more need be done; the requisite quantity can be thrown into the scouring vat, either with or without the addition of a small quantity of carbonate of potash to increase the alkali present. The potash soap produced in this way is very much more concentrated than the ordinary "fig soap" hitherto sold. If it is required to make a soft soap similar in appearance and quality to the ordinary fig soap, it can be produced in the following manner: Take 200 pounds of the stiff potash soap, and add to it about seven gallons (70 pounds) of water. Put it into a boiling pan, and gently heat and stir it so as to mix well together; then add about six to eight pounds of crystalline carbonate of potash, which will remove all "stringiness" and produce a clear, homogeneous soap, which also will improve in appearance by keeping for a short time.

The above "cold process" is simple and effective, and even a few pounds alone of soft soap can be made by it; with mechanical mixing apparatus and large pans, soft soap can easily be produced on a large scale by this process. If, however, it is wished to make the soap by the old boiling process, the best way to do so is as follows:

Take 20 gallons of cotton-seed oil, and put it in a pan with 21 gallons of lye of 15° T., made from Greenbank caustic potash, and gently heat by boiling until well mixed. Now add 7½ gallons of caustic potash lye of 40° T., and continue boiling, when the soap will become stiff and difficult to work. To overcome this and take away "stringiness," add about six pounds of fine crystalline carbonate of potash, and continue boiling the soap until it is thoroughly mixed and finished. In this way, even with the old boiling process, soft soap can be much more easily and readily made than with Montreal ash or German carbonate of potash.

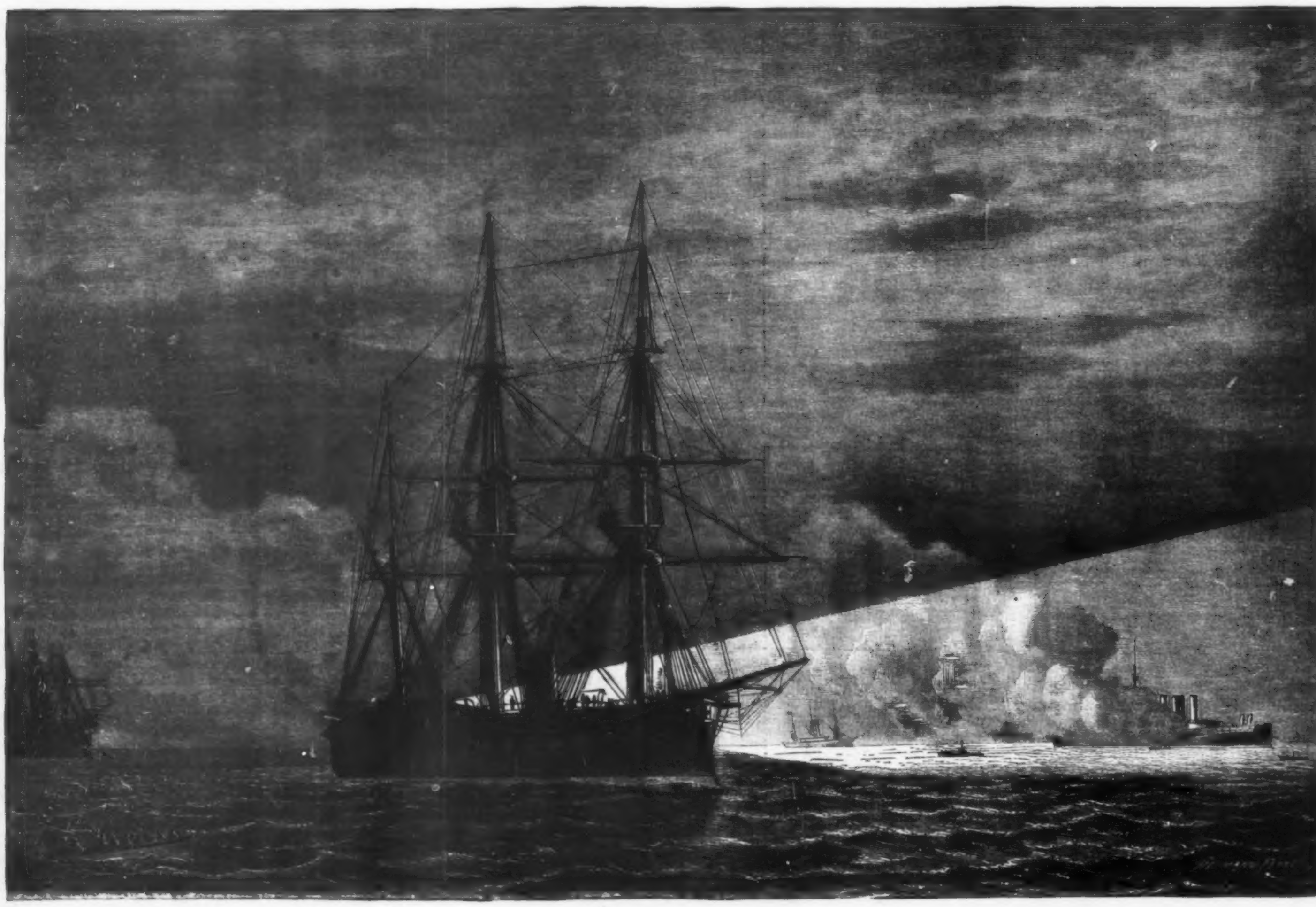
As before mentioned, cotton-seed oil is the best to use in either process. For some purposes, however, a small addition of tallow rather improves the soap; if this is desired substitute in the proportion of about eight and a half pounds of tallow for each gallon of oil given in the directions. Linseed oil, or fish oil, can be partly or entirely substituted, but the peculiar smell given to the soap by the use of these oils is in many cases objectionable. Tallow or grease can be used entirely; the result will be a soap quite satisfactory for most fulling and washing purposes, but it will be opaque, and not of the same appearance as a potash oil soap. The addition of some hemp-seed oil to the cotton seed oil will give a color similar to that obtained when olive oil alone is used. It will be evident also that the soap can be made stronger or milder, as required, according to the quantity of caustic potash used, or the crystalline carbonate of potash added at the end of the process; it will be found generally more satisfactory to regulate the strength of the fulling soap with carbonate; or for actual consumers, which is better, carbonate of potash can be added to the scouring vat when the soap is used for scouring or cleaning.

Soda ash, or any other form of soda, never should be

used in conjunction with a potash soap; if this is done it destroys the whole advantage of the potash soap, and it will be better at once to use a hard soda soap. For scouring or removing oils from woolen manufactured goods, even when soap is not employed, carbonate of potash should always be used, and never soda ash or soda crystals. For this purpose take either the best Montreal pearl-ash, or what is better and cheaper, the fine crystallized carbonate potash, lately introduced by the Greenbank Alkali Company, as it dissolves immediately in cold water, and besides being cheaper is much more uniform than Montreal pearl ash, as this article varies so much in quality.—*Chemical Review.*

THE ELECTRIC LIGHT IN THE GERMAN NAVY.

DURING the sojourn of the German Crown Prince in Kiel on July 27 and 28 of this year, the armored frigates Friedrich Karl, Sachsen, Preussen, and Friedrich der Grosse, of the German Navy, were ordered to participate in a sham battle at night. The entire combat was based upon the assumption that the ships were not provided with sufficient netting to protect them from fish torpedoes, and were therefore required to keep a sharp lookout. To assist the guards two very powerful electric lamps were provided at the stern of the frigate Friedrich Karl, and on the steam dispatch boat Grille, and lighted up the waters for a distance of seventeen hundred to twenty-five hundred feet, thus making it impossible for the torpedo boats to approach the frigates without being detected.



Armored Frigate Friedrich Karl. Dispatch Boat "Grille." Torpedo Boat. Armored Frigate Sachsen.

THE ELECTRIC LIGHT IN THE GERMAN NAVY.

Our cut, taken from the *Leipziger Illustrirte Zeitung*, represents the attack of the torpedo boats, and shows the brilliant effect of the electric light on the waters.

INTERESTING FACTS ABOUT ELECTRICITY AND GAS.

THE following letter by Dr. Siemens has been forwarded to the London *Times*, in reply to that of Mr. W. H. Preece, on "Electricity in Collieries," which appeared recently:

Mr. W. H. Preece, in addressing you under the title of "Electricity in Collieries" on the 28th October, points out, very properly, I think, that the employment of the electric light would not be without danger in coal mines, because the electric arc and an accidental spark between conductors would be liable to fire a gaseous explosive compound. When examined before the Royal Commission on Accidents in Mines, I gave evidence to this effect, suggesting only an indirect application of the electric light, by which, if successful, the chances of accident would be minimized. I am not prepared, however, to follow Mr. Preece in his assertion that the electric light generally and under ordinary circumstances is an illuminant dangerous to life and property; his statements in this respect have actually caused unnecessary alarm to those who have trusted electricity for the illumination of public buildings. Mr. Preece says that "if a mere crack or pinhole were to occur in an insulating coating the currents would escape to earth, generating heat and producing fire," emphasizing this statement by asserting that it is not a chimerical one, but the result of practical information of his own. Now, the dynamo-electric current is powerful in the sense of doing a large amount of work, but its intensity is so moderate that it is only by rubbing the two unprotected conductors against one another that vivid sparks are produced. The interposition of a thin shaving of wood or other inflammable substance would in itself supply a sufficient insulating separator to prevent the spark, and I challenge Mr. Preece, notwithstanding his well-known skill as an experimenter, to the production of an igneous discharge through a mere pinhole in the insulating covering of one or other of the conductors. In practically arranging electric lights for public buildings the insulated conductors are entirely separate, and the likelihood of danger to buildings is absolutely removed by the precautions taken. Mr. Preece's reference to the unfortunate musician and Russian sailor, who appear to have been struck dead by electric discharges while assisting to put up electric lights, is somewhat sensational. They must have been predisposed to succumb to an electric shock, and must have grasped firmly the two unprotected leading wires with moist bands; for I and many other persons have frequently touched both poles of a powerful dynamo machine without feeling any the worse for it. At the same time there are dangers connected with the establishment of this, as of almost any apparatus or machinery, which do not in any way apply to the user not set upon courting danger.

Mr. Preece also charges the electric light with being cold in appearance, but in reality "the greatest source of heat which science possesses." Now, I quite agree with him in this latter proposition, and have, indeed, constructed an electric furnace for fusing highly refractory materials; but I wish to guard against the inference that because the electric arc is hot, electric light must necessarily heat rooms in which it is employed to anything like the same extent as gas, or, indeed, any other illuminant. The following simple calculation, based upon actual experiment, will show what is the relative heating effect of the two sources of light within a room. To produce 4,000 candle power by electricity requires a current of 34 webers, which again represents 130 heat-units per minute. To produce the same amount of light by gas takes 200 Argand burners, consuming 16 cubic feet of 20-candle gas per minute, which consumption represents 15.000 heat units. Some additional heat will be produced in the electric arc, however, by the combustion of the carbon electrodes, which consumption amounts to 6·8 grains of carbon per minute, and will produce in combustion 12·5 heat units. The total amount of heat produced by the electric arc is, therefore, $130+12{\cdot}5=142{\cdot}5$ units per minute, or rather less than 1 per cent. of the heat developed with the same amount of light by means of gas. Gas lights produce, however, the further inconvenience of displacing the oxygen of the air by carbonic acid, and by a minor, but still very sensible amount of sulphurous acid.

GAS AS A FUEL.

If this calculation militates against gas as an illuminating agent, it proves, on the other hand, its great value as a heating agent; and just now, when so much is said about the smoke nuisance, I may be allowed to add a few words on that subject. For upwards of 20 years I have been actively engaged upon the development of a system of working furnaces for the manufacture of iron, steel, glass, etc., by means of gas fuel produced in a simple gas-generating apparatus. Some thousands of these gas producers are in operation, and furnish daily proof that gas may be used with economical results; and the smoky factory chimney, where it still exists, proves simply a disregard for the principles of economy. In the year 1858 I was anxious to take a further step in the same direction in proposing to supply towns with heating gas, and, having induced the Town Council of Birmingham to support my plans, measures were taken to obtain Parliamentary power to carry them into effect. It was intended to separate the two constituents of coal by a comparatively inexpensive method, supplying gas of low illuminating but high heating power to consumers at a cheap rate, and reserving the coke for use in locomotive engines and stoves, for which purpose it is eminently better suited than raw fuel. Unfortunately the bill was thrown out by a committee of the House of Lords in consequence of the opposition of the existing gas companies, and the proposal has remained in abeyance ever since.

GAS FOR FIRE GRATES.

While it is admitted by many that gas fuel can be used advantageously for heating furnaces, there still exists great objection to its use upon the domestic hearth, which is one of the largest sources of consumption of raw coal, and certainly the cause of a great amount of smoke in our metropolis. The gas fireplace sometimes used does not meet with public favor, owing to its uncheerful appearance, great consumption of gas, and most of all, from the smell which frequently results from its use. It is said to produce a "dry" heat—a term which, to my mind, conveys no definite meaning, seeing that the heat produced by an open fire place is purely radiated heat, precluding the idea of moisture; but I have observed that in the usual gas grates, consisting of a number of gas jets spread over the grate, and covered in with pumice stone or asbestos, the heavy gases resulting from the combustion descend through the grate bars, and thus find their way into the apartment.

I have lately constructed in my own house gas grates that are certainly free from the defect just named, and which are at the same time economical and cheerful in their appearance. The arrangement consists in substituting for the fire grate below a solid plate, so as to exclude all communication with the atmosphere, except through the front bars.

A gas pipe perforated above with a certain number of small holes is connected to the ordinary gas service. The grate is filled with ordinary gas coke or anthracite, banked up well toward the back. In this way a cheerful fire can be kindled at any time by opening the gas tap and putting a lighted match to the grate. The gas flames, acting only in front of the grate, soon cause the surface of the coke to glow, without depriving the beholder of the cheerful appearance of the flame. In the course of half an hour the surface of the heap of coke is fairly red-hot, throwing out fully as much heat as an ordinary fire, while not a particle of flame or smoke reaches the chimney; the combustion of the gas prevents the rapid consumption of coke in front, and the absence of its consumption toward the back of the fire. When fairly ignited the gas may be almost turned off, because the coke, once well heated, continues its glow by slow combustion with the atmosphere. An ordinary grate may be converted into a coke gas grate as just described at a very trifling cost, and will be found convenient and inexpensive in its use even when using illuminating gas at 3s. 6d. per thousand cubic feet. Its economy will be materially increased by a sort of regenerative arrangement by which the heat, gradually accumulating at the back of the fire, is utilized to supply the gas flame with a current of hot air—an arrangement which it would take too much space to describe, but which I shall be happy to place at the disposal of the association recently formed with the laudable object of improving our winter atmosphere.

A NEW ELECTRIC MOTOR AND ITS APPLICATIONS.

ON the 28th of last June, M. Trouvé addressed to the Académie des Sciences a note relative to the improvements made in coils of the nature of those of Siemens. We give herewith figures of his new motor based on these improvements. To show the reader the idea that M. Trouvé has followed up in order to arrive at his results, we reproduce the following passage from his note to the Académie:

"When we trace the dynamic diagram of a Siemens coil, on causing the latter to make one complete revolution between the two magnetic poles which are reacting upon it, we observe that the work is almost null during two quite extended periods of its rotation. These two periods correspond to the time during which the cylindrical poles of the coil, having reached the poles of the magnet, are passing before them. During these two fractions of the revolution (which are each about 30°) the magnetic surfaces designed to react on each other remains at the same distance, and the coil is not then incited to revolve. The result is a notable loss of work. I have gotten rid of these two periods of indifference and increased the useful effects of the machine, by modifying the polar faces, so that instead of being portions of a cylinder whose axis coincides with the old system, they are snail shaped, and thus in revolving gradually bring their surfaces near those of the magnet up to the moment at which the posterior edge *escapes* the pole of the latter. The repelling action then begins, and a dead center is thus practically avoided."

FIG. 1.—TROUVE'S NEW ELECTRIC MOTOR.

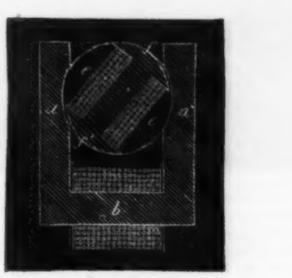


FIG. 2.

Fig. 1 gives a perspective view, one-half actual size, of a motor constructed on these principles, and Fig. 2 gives a vertical section with a horizontal projection of it. The motor is capable of driving a sewing machine with a Bunsen or Reynier pile of a few elements. The prominent features possessed by this new motor may be summarized as follows: (1.) Although of very small size, it has a relatively great power. (2.) The electro-magnetic effects are utilized under the best possible conditions for available work, since the inductor is very close to the armature, which almost completely incloses it (Fig. 2). (3.) The suppression of dead centers with a single movable electro-magnet is complete—a thing of rare occurrence in mechanics, and which would have had an immense influence had it been applied to the steam engine instead of to the electric motor. (4.) The direct reaction on each other of two magnets placed in the same circuit allows the power to be indefinitely increased with that of the current employed—this power having for a limit only the resistance of the parts to breakage. (5.) The motor will run with great velocity—even up to two hundred revolutions and beyond per second. (6.) No spark forms at the commutator, the current being never broken. (7.) The motor is reversible, and may, by slight modification, be employed to generate electricity. (8.) Finally, it is moderately cheap. Figs. 3, 4 and 5 are variations of the motor in which M. Trouvé has arrived at satisfactory results by making in some cases the inductor, and in others the armature, eccentric.

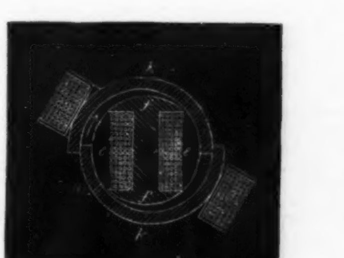


FIG. 3.

Fig. 6 shows the application of the motor (Fig. 1) to the propulsion of small boats. The arrangement is so simple that it requires even no change in the construction of the boat. The rudder bears within itself all the mechanical elements—motor, propeller, and conductors—and forms a movable unity. The screw and its axle occupy the lower part of the rudder in an aperture made for this purpose, and is actuated by the motor (which is located at the top of the rudder) through the medium of a belt or cord. The electro-motive power furnished by the generator, which is placed in the boat, is transmitted to the generator by means of flexible metallic cords. The rudder is fitted to the boat in the usual manner. In case it be desired to use oars only for propelling the boat, the screw, being no longer actuated by the motor, becomes free, and revolves in the opposite direction. For the last few months M. Trouvé has been making numerous experiments with his motor on the Seine with an 18 foot yawl-boat used for hunting waterfowl. The game, being no longer frightened by sound of oars, was easily approached. At the very first, the speed of this yawl was about 4 feet per second; but, after certain modification of details, M. Trouvé has succeeded in giving it a speed of 6½ feet per second.

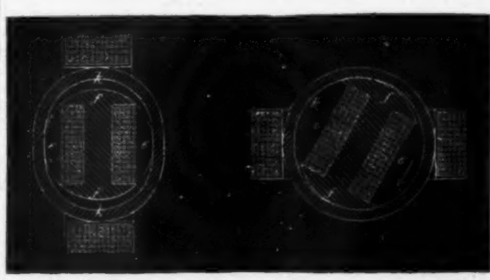


FIG. 4. FIG. 5.

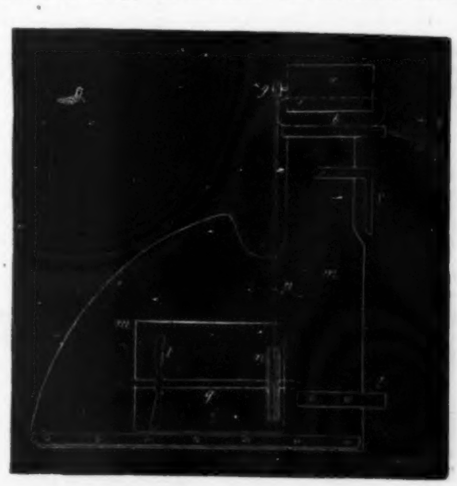


FIG. 6.

M. Trouvé does not think that, with their present resources, ordinary workmen will be able to afford the expense of running these motors for their own use, and has therefore turned his attention more especially to making them applicable to the purposes of dentists, watchmakers, and amateurs, who need a cheap and efficient power for running lathes. Professors of physics will find in the machine a valuable acquisition to their cabinets; for it will serve as a powerful aid in the performance of numerous experiments which necessitate the use of mechanical power—such as actuating the Holtz machine, chromatropes, etc., etc. Physicians can also use it for making their electrical machines. Finally, there are undoubtedly in reserve for it numerous applications in the arts and industries.

ON HEAT AND LIGHT.

By ROBERT WARD.

ACCORDING to the modern scientific idea, heat is a "mode of motion." Prof. Tyndall, who has done so much toward popularizing this view of heat, describes it as "an accident or condition of matter; namely, *a motion of its ultimate particles*." He discards the material theory which supposes heat to be "a kind of matter—a subtile fluid stored up in the inter-atomic spaces of bodies." Yet for a long time the latter had the greater number of supporters eminent in science.

It is not my intention to suggest that either the one or the other theory is devoid of truth. I have elsewhere shown that all things exist by virtue of their circumstances, and that, as the circumstances of all things are continually changing, all things must be continually changing. (See "Constitution of the Earth," p. 4.) That such change is always going on is rendered obvious by the amazing fact that everything *grows older*. Even wine, however preserved from contact with surrounding objects by being hermetically sealed in a glass bottle, undergoes a change well known to the toper, though undiscoverable by the analytical processes of the chemist. That this change is a never-ceasing one is as evident as that a body falling from an elevated position must pass through all the intermediate points of space before it reaches the ground. There may be no evidence of any substantive addition to, or withdrawal from, the contents of the bottle; nevertheless the wine *has grown older*, as discoverable by the sense of taste, and by such change, up to a certain point, it is, humanly speaking, "improved." It cannot be doubted that, from the time a human being comes into the world till he passes out of it, the entire phenomena of life consists of an unceasing change. Infancy, youth, manhood, and old age are only terms by which we recognize the more prominent phases of a never-ending, still beginning evolution. To indicate their appreciation of such change, chemists formerly told us that in seven years every molecule of the original substance of the human body had been removed and substituted by other molecules. The more modern idea is that this takes place at much shorter intervals; but is it not obvious that a human being is never for a single moment exactly what he was the moment which immediately preceded?

Now what is change but motion? And yet it is *more* than motion: however imperceptible it may be, it is part of the process of *transformation* by which the wine is improved, and by which the child becomes a man. The effect is not a mere mechanical rearrangement of parts—not only "vibration" or "clashing of atoms"—but a constitutional or radical difference, however small, between the original and present states. Either "something" has been taken or something has been added; and is it not probable that something has been both taken and added, by which the change has been produced? We may call that something "matter," or we may call it "an accident or condition of matter;" the change could not have taken place without motion, but *neither could it have been produced by motion alone*.

In the volume to which I have referred I have shown that, on the assumption that all things exist by virtue of their circumstances, it follows that "a change in the circumstances of things necessarily involves a corresponding change in the things themselves." This I have described as "the law of motion." Hence it is that—as nature is never at rest, as worlds and systems of worlds are always moving, and as all the other bodies of space, small or great, are perpetually taking up new positions in relation to each other—every bit of matter in the universe, every atom or molecule, is perpetually undergoing a process of change. May we not assume that heat is one of the forms of this change? It is undoubtedly true that, according to the extent or degree of this change, we must have motion; and according as this motion in extent or degree appeals to our sense of feeling, by adding to or subtracting from the natural warmth of our bodies, we employ the terms heat or cold to express our estimate of the character of the phenomenon.

The truth is that all things in nature are united together by a constitutional relationship, of which the action of heat upon our organism is one of the manifestations. We become mentally acquainted with this relationship by means of the senses of seeing, feeling, hearing, tasting, etc. When I look round the room in which I am sitting, I see articles of various forms, sizes, and colors—*e. g.*, chairs, tables, pictures, etc. Why do I see them? I may be told that it is because rays of light are reflected from the objects to my organs of vision; and it is true that without light I could not see them. But neither could I see them without eyes; and yet it is evident that, whether I see them or not—whether my eyes are open or shut—the relationship between the objects and my organism, *so far as it is mechanical*, must always be the same as long as they and I remain unmoved. The objects, in fact, exist independent of either the light or my eyes, but the actual perception of them is due to certain qualities which are impressed upon my organism when the necessary relationship is established. Thus there are three factors necessary to sight—eyes, objects, and light. The qualities by which objects are revealed to us are color, form, and size. Really, however, so far as the visual perception of things is concerned, color is the basis or foundation of sight, form and size being due to a perception of differences in color, and to the limitation or extension of such differences. Thus I can only see the chairs, tables, pictures, etc., by virtue of the light which strikes upon their surfaces and reveals to me various colors, or shades of color, the perception of which (by contrast) is the foundation of my knowledge.

As in the case of heat, light was believed by Newton to be due to the emission of a subtile fluid, but modern science repudiates the teaching of the great philosopher as to both light and heat, and they are now severally described as simple "modes of motion." Heat, we are told, is a clashing together of the ultimate particles of matter; while light is due to the vibrations of a luminous ether wholly unknown to the senses, but which fills all space and penetrates between the molecules of all bodies. White light, as it reaches

us from the sun, is a compound or mixture of many colors. The different colors of bodies are said to be due to the way they reflect the different kinds of light, by creating in the imaginary ether waves of different lengths. These waves, though as infinitely numerous as the shades of color, are supposed to move simultaneously and perfectly distinct, so that each will produce its own separate and characteristic effect upon the organs of vision.

Such is the modern scientific theory as to the creation of colors. I must confess that my understanding is not so much enlightened by it as by the emission theory of Newton. The solar spectrum exhibits seven principal colors, but these imperceptibly merge into each other through an infinity of intermediate tints. I find it hard to imagine seven waves of different lengths, all moving with equal speed and striking the retina of the eye at the same moment; but I am totally unable to realize the idea of an *infinity* of different lengths of waves—representing the infinity of intermediate tints—striking the retina in the manner described. If I must penetrate the mystery, I confess that it seems easier to comprehend the emission than the undulatory theory. I know that all things are growing older, and therefore undergoing an unceasing change, and I cannot understand how such change can take place without the emission of *something*. What is that something? It seems to me that it is the cause of all the changes perpetually taking place in nature. It is by this emission (or by this absorption) that I become acquainted with the several qualities of things and their relationship to my own organism. Something is constantly passing between all bodies, by which they act and react upon each other; by which they are at once separated and united; by which all change—mechanical, chemical, and physiological—is produced, and which is at the same time the origin of life and the cause of decay. This something appeals to our senses in many phases—as heat or cold, as odors, as sounds, as colors, differentiated into forms or sizes, as tastes, as the various impressions of touch or feeling, etc. This something, in its many forms and qualities, in its attractions and repulsions, and, in short, by the infinity of its phenomena, constitutes the *reality* of which gravity is the *abstract conception*. For, as Newton himself suggested, gravity is due not to "occult qualities supposed to result from the specific forms of things, but *as general laws of nature by which the things themselves are formed; their truth appearing to us by their phenomena*, though their causes be not discovered."

Nor are the impressions of distant objects communicated through the senses of no physical account in building up the living organism. Such impressions fix themselves more or less permanently in the memory, and assist in creating the brain tissue by which memory itself is established. The brain may, in fact, be described as a storehouse of such impressions, in which are gathered not only the experience of the living individual, but of all his ancestors to the remotest conceivable beginning. And as is the brain, so is the body. The inconceivably attenuated matter (or something) which strikes upon our senses from surrounding objects may be said to have in it "the promise and potency of every form and quality of life."

Of all the impressions received from outward objects, those of heat and light are the most active in producing change. Heat is the moving agent in all manufacturing processes having for their object the speedy conversion or transmutation of bodies, and heat and light are the most important elements in connection with all the phenomena of vital action. By their means, out of the same soil and air is evolved the tender bud, the green leaf, the woody fiber, every form and description of vegetation, every variety and tint of color, every kind of odor, and numerous other qualities by which our several senses are either obnoxiously or agreeably influenced.

And yet it is said that light and heat can create nothing or destroy nothing; that they are mere modes of motion—the action of the "eternal and imperishable" parts of the huge machinery of the universe, which change only in their relation to each other and not in their constitution. If this meant that heat and light can, in the absolute sense, create or destroy nothing, no objection could reasonably be made. We know nothing of either matter or motion beyond the impressions which they communicate to our consciousness through the senses. The forces of nature may indeed be described as only the agents by which the Supreme Creator works out His purposes in the universe; but are we not, therefore, all the less justifiable, when we see these wonderful creations of light and heat, in denying that they are, what they appear to be, transmutations, in some degree, of the several materials or objects out of which they have been constituted? That is, a transmutation (not of abstract matter, which is only a metaphysical conception) of the several qualities by which the objects are presented to our consciousness, and by which alone they are known to us?

While some scientists treat heat as only a mode of motion, an accident or condition of matter—others constantly refer to it as an entity of absolute power. Hence we read of calculations to determine how much of the sun's heat is utilized in warming the planetary bodies, and how immensely more is wasted in space. I do not dispute that the sun, like everything else in nature, is undergoing changes, or "growing older;" but let this be remembered, that heat, such as it is known to us on the earth, may be something very different at its source; that, in fact, there is no reason to believe that the sun is being burnt up like the coals upon our fires. On the contrary, there is much reason to believe the reverse. Only a few miles up in the air it is freezing cold; the light rays illuminate the regions above the clouds, but the heat rays *are absent!* Certainly no evidence this of immutable heat (or even of heat such as it is known to us by combustion) radiating from the sun into space. If we place a sheet of glass before the fire, the heat rays are stopped till the glass itself becomes hot; or if we place a sheet of ice in the same position, the same result ensues till the ice is melted. On the assumption that the sun is throwing off heat like a fire, the thin air of the upper regions acts like a sheet of glass or ice, with this remarkable difference, that the heat never raises the temperature of the air, and yet (apparently, at least) *it gets through it*, as known to our consciousness on the earth's surface! The heat gets through, but not as the heat known to our senses, for Rumford showed that calorific rays can be passed through a vacuum without losing their temperature in the passage. The question of the temperature of the sun has been the subject of investigation by many scientists. Newton, one of the first investigators of the problem, tried to determine it, and after him all the scientists who have been occupied with calorimetry have followed his example. All have believed themselves successful, and have formulated their results with great confidence. The following, in the chronological order of the publication of the results, are the temperatures (in centigrade degrees) found by each of them: Newton, 1,669,300°; Pouillet, 1,461°; Zöllner, 102,200°; Secchi, 5,344,840°; Ericsson, 2,726,700°; Fizeau, 7,500°; Waterston, 9,000,000°; Spoerer, 27,000°; H. Sainte-Claire Deville, 9,500°; Soret, 5,801,846°; Vicaire, 1,398°; Violle, 1,500°; Rosetti, 20,000°. The difference is, as 1,400° against 9,000,000°, or no less than 8,998,600°! There probably does not exist in science a more astonishing contradiction than that revealed in these figures.

Another of the fallacies respecting heat upon which some curious theories have been founded as to the earth's future destiny, is that of assuming that all but its crust is a mass of liquid fire. In support of this intense central heat, it was at one time asserted that the temperature of deep mines invariably increased in proportion to the depth; but doubts have, in late years, been thrown upon the statement. Still it is confidently asserted that the interior of the earth is in a red-hot molten condition, and that it is radiating its heat into space, and so growing colder. One of the results of the Challenger and other explorations of deep ocean is to determine that the water toward its bottom is freezing cold. Considering that the ocean covers nearly three-fourths of the entire globe, this fact certainly does not support the theory of central heat accompanied by radiation. The coldest water, it is true, usually sinks by its greater weight toward the bottom, and that, it may be said, accounts for its coldness; but, on the theory of radiation, the water of the ocean has been for long geological ages supported on the thin crust of the earth, through which the central heat has been constantly escaping; and yet it is still of freezing coldness! Experience would say that the heat cannot have escaped through the water without warming it, because the capacity of water for heat is greater than that of any other substance. We can no more imagine such a radiation, and consequent accumulation of heat in the ocean, without the natural result of a great rise in temperature, than we can believe in a kettle resting for hours on a hot fire without the usual result of boiling water. We have no reason, therefore, to believe, as has been suggested, that the earth is growing colder, or that we, in common with all living things, are destined to be frozen out of existence and the earth itself finally swallowed up by the sun.—*Journal of Science.*

PHOTOPHONIC EXPERIMENTS OF PROF. A. G. BELL AND M. SUMNER TAINTER.

By A. BREGUET.

THIS paper cannot be reproduced without the accompanying illustration. The question arises whether it is light or heat which is brought into play. M. Bell has placed before the pencil of rays a solution of alum and then a solution of iodine. In the former case the sonorous effects were little reduced in intensity, while in the latter scarcely any sound was heard.

DISTRIBUTION OF LIGHT IN THE SOLAR SPECTRUM.

By J. MACÉ and W. NICATI.

IN all cases the maximum intensity is in the yellow at a point very near to the ray D, in conformity with the generally received opinion. The intensity decreases very rapidly from this point on either hand, and becomes very feeble in the blue. The perception of the blue and the violet diminishes much more slowly with the decrease of illumination than does that of the less refrangible colors. From the extreme red to the green of the wave length 0·5μ, the law of the distribution of intensity remains absolutely the same, whatever may be the illumination. Even between eyes equally capable of distinguishing colors there are very sensible differences.

MOUNTING MICROSCOPIC OBJECTS.

DR. H. STOLTERFORTH, M.A., in a communication to the Quekett Club recommends boiling in soap and water as a means of cleaning Diatomaceous materials, in all cases where it is available, in preference to the ordinary mode of treatment with acids and strong alkaline solutions. He considers it far less liable to do mischief to the delicate organic structures under treatment than the ordinary methods.

IN a paper read before the Royal Microscopical Society, Mr. J. W. Stephenson demonstrated that the visibility of minute objects depended upon the difference between the refractive index of the medium in which they were viewed and that of the objects themselves, and, further, that it was useless to employ objectives of the large apertures now attainable unless the objects were mounted in media capable of utilizing the whole of large pencil; by using them on objects mounted in air their effectiveness is reduced to the common level of 180°=1·0 numerical aperture. The following table of indices is given:

Air	equal	1·00
Water	"	1·33
Diatomaceous silex } Sulphuric acid }	"	1·43
Canada balsam	"	1·54
Bisulphide carbon	"	1·68
Solution of sulphur in bisulphide carbon (approximately)	"	1·75
Sulphur	"	2·11
Solution of phosphorus in bisulphide carbon (approximately)	"	2·10

Taking the difference between the refractive indices of diatomaceous silex and the several mounting media, the following results are obtained:

Water	10
Canada balsam	11
Bisulphide carbon	25
Solution of sulphur in bisulphide carbon	32
Solution of phosphorus in bisulphide carbon	67

The practical result of the investigation appears to be—

That it is essential, if the whole aperture of an objective is to be utilized, to mount minute structures in some medium other than air.

That although the full aperture and revolving power are secured by mounting in balsam, it gives nevertheless nearly the faintest image of all.

That a solution of phosphorus is, as far as visibility is concerned, by far the most effective, but the difficulties attending its use must render it unpopular.

The next best is a solution of sulphur in bisulphide of carbon (although pure bisulphide is very good), and with these there is no technical difficulty whatever. This medium can easily be secured by using the solution employed by Mr. Browning in making his bisulphide prisms. A ring being made on the slide, and a drop of the sulphur solution or pure bisulphide being placed in its center, nothing is necessary but to place over it the thin cover with its adhering diatoms, press it down on the still moist ring, running round it a somewhat copious margin of the cement. When dry, to protect it from the water of the ordinary immersion lenses, it is desirable to give it a coat of gold-size or shellac varnish.

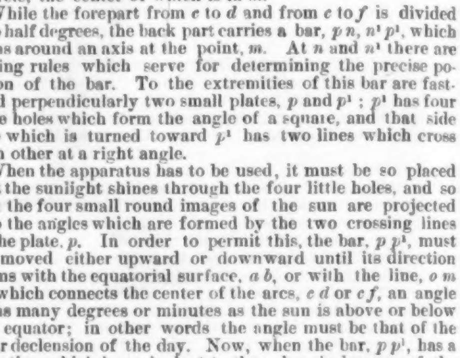
NEW SUN DIAL.

By M. GROOTTEN.

THE basis of this new instrument is formed by an inclined disk, *a b*, which is divided into hours and into partitions of five minutes. This disk rests upon a foot, *h*, the lower part of which is provided with three points, which enables the instrument to be so placed that the disk forms with the horizon an angle equal to the equatorial altitude of the place. The disk, *a b*, is therefore parallel to the equator of the earth or heavens when it is directed north or south. Upon the center of this disk is a movable axis, and upon this axis a needle, *i k*, provided at its extremities with sliding rules (verniers), and upon which the plate, *c d i k e f*, is perpendicularly fastened; *c d* and *e f* are, besides, part of a circle, the center of which is in *m*.

While the forepart from *c* to *d* and from *e* to *f* is divided into half degrees, the back part carries a bar, $p\,n$, $n^1\,p^1$, which turns around an axis at the point, *m*. At *n* and n^1 there are sliding rules which serve for determining the precise position of the bar. To the extremities of this bar are fastened perpendicularly two small plates, *p* and p^1; p^1 has four little holes which form the angle of a square, and that side of *p* which is turned toward p^1 has two lines which cross each other at a right angle.

When the apparatus has to be used, it must be so placed that the sunlight shines through the four little holes, and so that the four small round images of the sun are projected into the angles which are formed by the two crossing lines of the plate, *p*. In order to permit this, the bar, $p\,p^1$, must be moved either upward or downward until its direction forms with the equatorial surface, *a b*, or with the line, $o\,m\,o^1$, which connects the center of the arcs, *c d* or *e f*, an angle of as many degrees or minutes as the sun is above or below the equator; in other words the angle must be that of the solar declension of the day. Now, when the bar, $p\,p^1$, has a direction which is equivalent to the solar declension of the day of observation, by its aid, the exact equatorial position of the plate, *a b*, can be easily determined. There are only



two positions of this plate possible, by which the solar images will have the required position, the one in the forenoon, the other in the afternoon. Except at the hour of noon there can be no doubt as to which of the two positions has to be chosen, and by taking aim with the eye the position of the bar by which the images of the sun are reflected in the desired manner can be easily established.

First, without touching the bar, *i k*, with the plate, *c d e f*, is turned so that the shadow, p^1, falls upon *p*; the position of this plate has now to be fixed by screwing the foot up or down, till the solar rays pass through p^1, and strike *p* at the exact height, then the needle, *i k*, is turned until the luminous little circles have their position between the angles of the cross, an observation which can be made with great precision.

At this moment the plate, *a b*, has attained the desired position, and the hours can be read off at the extremities of the needle, *i k*. Taking the changes in the declension into consideration, the correct position of the apparatus may be verified at different hours, a single observation being always more or less inexact. When the correct position of the sun dial has been found, it is only necessary to pay attention to the plate, *c d e*. This plate remains in its place, and the apparatus is turned from above around its axis, *g*, and the bar, $p\,p^1$, around its center, *m*, until the solar images appear at their place. The hour can now easily be found. The sun dial can be removed from its place after the observation is finished, and its correct position can be readily found again, if the position of the three points of the foot is carefully marked. This apparatus will be of great advantage for the operation of city clocks, and is sold by the inventor, with the exception of its brass basis.

ANTOINE CESAR BECQUEREL.

ANTOINE CESAR BECQUEREL, the distinguished French physicist, was born at Chatillon-sur-Loing, March 7, 1788. He received his education at the Polytechnic School, which he left as an engineer officer in 1808, and served as such with the army in Spain. In 1815 he retired with the rank of major, having the year pevious been named Inspector of the Polytechnic School. In 1819 he began the publication of his mineralogical and geological researches. In investigating the physical properties of amber, he was led to experiment on the discharges of electricity by means of pressure, and this was the starting point of nearly all his subsequent investigations. These researches led to the refutation of the "theory of contact," by which Volta had explained the action of his pile or battery, and to the construction of the first electrical apparatus with a constant current. M. Becquerel's various memoirs on different branches of electricity, etc., have been published in the *Comptes Rendus* of the Académie des Sciences and in the *Annales de Physique*

et de Chimie. His investigations enabled him to discover a very simple method of determining the temperature of the interior organs of man and the lower animals. Of this method he made numerous physiological applications, discovering that whenever a muscle is contracted a certain amount of heat is evolved. He was likewise one of the creators of electro-chemistry. In 1828 he availed himself of this new science in the production of mineral substances, and in treating by the humid process the ores of silver, lead, and copper. In consequence of these valuable researches he was elected a corresponding member of the Royal Society of London, and in 1829 he was made a member of the Académie des Sciences. In 1837 the former society awarded him the Copley medal for his numerous researches in electrical science. In the same year he was appointed Professor of Physics in the Museum d'Histoire Naturelle, and was also promoted to the rank of Commander of the Legion of Honor. Among the list of new substances which Becquerel obtained by the action of electricity may be mentioned aluminum, silicon, glucium, crystals of sulphur and of iodine, and numerous metallic sulphides, such as dodecahedral pyrites, galena, sulphide of silver, iodides and double iodides, carbonates, malachite, calcspar, etc. He also discovered a process of electric coloring on gold, silver,

ANTOINE CESAR BECQUEREL.

and copper, which has been extensively applied in practice. In his electro-chemical investigations, Becquerel's object was to discover the relations existing between the electric forces and the so-called chemical affinities, and to excite the latter into action by the former. All kinds of plating with gold or silver by the humid process are only so many applications of electro-chemistry. Many of his researches relate to the electric conductivity of metals, to galvanometers, to the electric properties of tourmaline, to atmospheric electricity, the effects produced by vegetation, the electromagnetic balance, to the use of marine salt in agriculture. M. Becquerel was a voluminous writer on science, the most important of his works being "Traité de l'Electricité et du Magnetisme" (7 vols., 1834–40), "Traité d'Electro-Chimie," and "Traité de Physique Appliquée à la Chimie et aux Sciences Naturelles." Besides these he published, in conjunction with his son, M. Edmund Becquerel, several works on meteorology, on agricultural chemistry, etc., etc., and on several divisions of electrical science, to which the father and son had devoted the larger part of their lives. M. Becquerel died on the 19th of January, 1878, at the advanced age of ninety years.

ON THE ETIOLOGY OF THE CARBUNCULAR DISEASE.*

By L. PASTEUR, Assisted by Messrs. CHAMBERLAND and ROUX.

ONE of the diseases which cause the greatest destruction of cattle is the *carbuncular disease*, or *anthrax*. Almost all portions of this country suffer from it; some in a slight degree and others very heavily. The pecuniary loss from this disease is very serious in some localities, as, for instance, in the department of Eure et Loire. Among the many herds raised there, there is hardly one which is not afflicted by it every year. Any farmer there considers himself fortunate, and even pays no attention to the disease, if his loss is not greater than from two to three per cent. of the number of animals in his flock. This disease is known in all countries. In Russia it is particularly disastrous, and it is called the *Siberian plague*.

For a long time the belief has prevailed that the carbuncular disease is due to various incidental causes, such as the nature of the ground, of the water, of the fodder; the methods of breeding and of feeding. Every cause has been invoked to explain its spontaneous existence. Lately, however, the researches of Messrs. Davaine and Delafond, in France, of Pollender and Branell, in Germany, have called attention to the existence of a microscopical parasite in the blood of animals who have died of this disease. Moreover, rigorous researches have disputed the doctrine of the spontaneous generation of microscopical beings, and the effects of fermentations have been attributed to specific microscopical germs. From these causes, the idea has arisen that possibly animals suffering from carbuncular disease may have acquired its germs, which are the germs of the parasite, from the exterior world, and that there is not, properly speaking, any spontaneous origin to this disease. This opinion became still more definite when, in 1876, Dr. Koch, of Breslau, published that the bacteridia, in its vibrionary or cacillary shape, may be resolved into germ corpuscles or spores.

Two years ago, I had the honor of submitting to the Minister of Agriculture and to the President of the Council General of Eure et Loire, a project of research on the etiology of the carbuncular disease, which was accepted with alacrity. I also had the good fortune to find in M. Manoury, Mayor of the Village of St. Germain, near Chartres, an enlightened agriculturist, who had the kindness to allow me to establish on his farm a small flock of sheep, under the same general conditions that are usual in the Beauce for sheep penned in the open air. Moreover, the Superintendent of Agriculture very obligingly placed at my disposal two shepherd pupils of the School of Rambouillet, to watch and feed the sheep.

The experiments began in the first days of August, 1878. These consisted in feeding certain lots of sheep with lucern, watered with artificial cultivations of the bacteridia of carbuncular disease, containing the parasite and its germs. Without entering into details in this place, I will give the following results of our experiments:

Notwithstanding the immense number of spores of bacteridia swallowed by all the sheep of one lot, many of them escape death, often after being visibly ill; others, in smaller numbers, die with all the symptoms of spontaneous carbuncular disease, after an incubation, which may extend to eight or even ten days, although toward the last the disease assumes those suddenly violent characteristics which have led some observers to think that the period of its incubation is very short.

The mortality may be increased in a marked degree by mixing with the food soiled by the germs of the parasite, bodies with sharp points, such as the pointed ends of thistle leaves, and the barbs of oats cut up into fragments about a centimeter in length.

It was important to ascertain if the *post mortem* examination of animals dying in these conditions would show lesions similar to those which are observed in animals who die spontaneously in sheepfolds or in open air pens. It was found that the lesions in all cases were identical, and the nature of these lesions authorize the belief that the disease begins in the mouth and in the back part of the throat. The first observations of this kind were made in *post mortem* examinations, conducted under our own eyes, by M. Boutet and by M. Vinsot, a young veterinary surgeon, and a graduate of the School of Alfort. Both of them have helped us with great zeal during all our experiments in St. Germain.

The idea that sheep which die spontaneously from the carbuncular disease in the department of Eure et Loire are infected by the spores of the bacteridia of this disease mixed with their food, acquired more consistency in our mind from these examinations. But whence come the germs of these bacteridia? If we reject every theory of the spontaneous generation of this parasite, we must direct our attention to the animals buried under ground.

We must here explain what is done when an animal dies spontaneously from carbuncular disease. If there is an establishment in the neighborhood for skinning animals, the body is taken there. If no such establishment is in the neighborhood, or if the hide is of little value, as is the case with sheep, a grave is dug from 0·50 to one meter deep and the body is thrown in and covered over with earth. This grave is dug wherever the animal has died, or in some neighboring field, if he dies in a stable. We may ask: What happens in this grave, and is there in it any cause for disseminating the disease? Many persons will answer in the negative, for Dr. Davaine has ascertained by accurate experiments that an animal who has died of anthrax cannot, after putrefaction, communicate the disease. Very recently numerous experiments have been made by one of the eminent professors of Alfort, a great partisan of the spontaneousness of all diseases. He has reached this conclusion: "That waters charged with the blood of animals who have died of carbuncular disease; that composts made by stratifying earth, sand, and stable manure with remains of bodies of dead sheep brought from Chartres, have never (by inoculation) caused the least symptom of carbuncular disease." (Colin, *Bulletin de l'Académie de Médecine*, 1879.) But here we must take into account the difficulties of this research, difficulties of which M. Colin was entirely unaware. To take specimens of earth from the fields of the Beauce, and show in them corpuscles from one to two thousandths of a millimeter in diameter, capable of infecting animals with the carbuncular disease, this is in itself a difficult problem. However, by proper washings, and by making use of the susceptibility of Guinea pigs and rabbits to contract the carbuncular disease, something could be done if the parasites of this disease were the only ones in the earth. But the earth must contain an infinite multitude of microscopical germs of various species, and in the cultivation of these on a living animal, or artificially in vessels, they interfere with one another.* During the last twenty years I have often called the attention of this Academy to the struggle for existence between microscopical beings. I may add that to isolate the carbuncular bacteridia from a portion of earth in which it may exist as germs, recourse must be had to special methods, whose application requires the most delicate attention. The action of air, of vacuum, changes in the nature of the media of cultivation, influence of variations of temperature; these are the means which must be used to prevent one germ from hiding the action of another. Any method of research which is not characterized by the most careful attention is powerless, and negative results only prove that, with the conditions in which the observations were made, the bacteridia did not show itself. The main argument presented by the eminent professor of Alfort is that the bacteridia disappears from the body of an animal as soon as it putrefies. This is an accurate statement, and the fact was known by those who flay and cut up the bodies of dead animals long before it was confirmed by Dr. Davaine. I have often heard these men, when handling the dead bodies of horses who had died of anthrax, when I put them on their guard against the danger they were running, say that there is no danger when the body is in an *advanced* state; the danger only exists when it is still warm. Although this fact is not strictly accurate, it agrees very well with what is true. In a previous investigation, published by M. Jaubert and myself, may be found the true explanation of the phenomenon. As soon as the bacteridia in its filiform state is deprived of air, if it is placed, for instance, in vacuo or in carbonic acid, it resolves itself into granulations of great tenuity which are dead and innocuous. Putrefaction places the bacteridia precisely in these conditions of disaggregation The germ corpuscles or spores do not go through the same process, as was ascertained by Dr. Koch. At any rate as the animals at the time of their death only contain the filiform parasite, putrefaction must destroy it entirely. If this opinion was accepted as explaining the facts that take place in nature, we would only have an imperfect idea of the truth.

When a horse, a cow, or a sheep, which has died of the carbuncular disease, is buried in the ground, we may imagine that in most cases some blood finds its way out of the body, even if the animal has not been wounded. A habitual characteristic of this disease is that at the time of death blood runs out through the nostrils, through the mouth, and even in the urine, which becomes red with blood. Besides, several days must elapse before the bacteridia are resolved into innocuous granulations by the gases free from oxygen which are produced by putrefaction. Meanwhile the excessive swelling of the dead body causes the liquids to run out through the natural openings, and through such ruptures as may exist of the skin and other tissues. The blood and other matters thus mixed with the surrounding portions of aerated earth are no longer in the same conditions as those of putrefaction, but rather in the conditions of artificial cultivation, suitable for the formation of the germs of the bacteridia. Does experiment confirm these preconceived ideas?

We have mixed blood from animals who had died of this disease with earth watered with yeast extract or with urine at the ordinary temperature of summer, and at such temperatures as are maintained by the putrefaction of dead bodies. In less than twenty-four hours, multiplication and production of germ corpuscles of bacteridia have taken place from the bacteridia in the blood. These germ corpuscles may afterward be found in a condition of latent life, ready to develop, ready to propagate the disease not only after weeks of stay in the earth, but even after years.

But these are only laboratory experiments. We must ascertain what happens in fields exposed to the open air, and to all the alternations of dryness and moisture. In the month of August of 1878, we buried in a garden of the farm of M. Manoury, a sheep of his flock which had died of the carbuncular disease, as verified by a *post mortem* examination. Ten months after this, and also fourteen months afterward, we took up earth from the grave, and we easily ascertained in this earth the presence of the germ corpuscles of the bacteridia, and, by inoculation on guinea pigs, we caused their death by the carbuncular disease. Moreover, and this is a circumstance worthy of note, the same investigation was carried on with earth from the surface of the grave, and the germ corpuscles were found to exist, although the earth of the grave had not been disturbed in the interval. Finally, similar experiments were made with earth from graves in the Jura of the depth of two meters, in which had been buried the bodies of cows that had died of this disease in the month of July, 1878. Two years afterward, which was quite recently, we have collected earth from the surface, and we have obtained deposits from it, which gave rise to the carbuncular disease. Three different times in this interval of two years we have obtained carbuncular disease from this same surface earth. We have finally ascertained that the germs on the surface of graves, in which animals are buried who have died of this disease, may be found after the operations of cultivation and after the gathering of crops. These last experiments were made in several places on the farm of M. Manoury. When these experiments were repeated on earth situated at a considerable distance from the graves, no carbuncular germs have been obtained.

I would not be surprised if, while I am speaking, doubts should rise in your minds concerning the accuracy of these observations. For how can the earth, which acts as a filter so thoroughly, allow microscopical germs to rise to the surface? Such doubts could easily find a justification in the experiments which M. Joubert and I have published. We have announced the fact that water of springs which rise from the earth, even from a moderate depth, are so entirely free from germs that they cannot produce a change in those liquids which are the most easily affected. The waters of springs, nevertheless, rise below portions of the ground through which rain waters are constantly passing, even during centuries, and their tendency is to carry downward the finest particles of the earth situated above these springs. There is certainly a great difference between such results and those to which I have called your attention, in which microscopical germs rise from below, even from great depths, in a contrary direction to the flow of rain water. Here is certainly an enigma. The members of this Academy will certainly be surprised to hear the explanation of it. You may even be astonished that the theory of germs, but lately born from experimental research, has in store such unexpected revelations. Earth worms are the carriers of germs, and it is to them that we owe it that the terrible parasite of carbuncular disease is brought to the surface from the depths of the earth, for it is in the little cylindrical agglomerations, and in the finer pellets voided by these worms, and deposited on the surface after heavy dews and after rains, that we find the germs of the carbuncular disease, together with many other germs. We may, by direct experiment, ascertain that it is to this agency that is due the transfer of the germs to the surface. If, in a volume of earth in which spores of the bacteridia have been mixed throughout the mass, we leave a number of earth worms for several days, we will, on opening their bodies, so as to carefully extract the earthy cylinders which fill their intestinal canal, find in these a great number of spores of the bacteridia.

If the loose earth at the surface of graves of animals who have died of the carbuncular disease contains the germs of the bacteridia, often in great quantities, they must originate from the disintegration by rain water, of the cylindrical excrements of earth worms. The dust from this disaggregated earth is thrown on plants growing at the level of the ground, and, in this way, animals in the open air find in some pastures the germs of the carbuncular disease, and become infected exactly in the same way as those in our experiments who fed on lucern, soiled by artificial cultivation of the bacteridia. These results lead us to meditate on the possible influence of the soil on the etiology of other disease, on the danger of cemeteries, and the usefulness of cremation!

Do not earth worms carry to the surface of the ground other germs which may, to the worms themselves, be as harmless as those of the carbuncular disease, but which may be the cause of disease to man and to domestic animals? They are, indeed, constantly filled with germs of all kinds, and in all cases the germs of the carbuncular disease are found associated with those of putrefaction and septicemia.

As to the prevention of the carbuncular disease, it seems easy of accomplishment. Animals must never be buried in fields in which fodder is raised or in which cattle are penned. Whenever such soils can be found, preference

* Translated from *Comptes Rendus de l'Académie des Sciences*, of July 12, 1880, p. 86, by P. Casamajor.—*Chemical News.*

* I am led to believe that in this infinite quantity of germs is to be found the true solution of the nitrification which Messrs. Schloesing and Müntz have shown to depend on fermentation. One day, if I remember rightly, in July, 1878, I received a visit from these excellent observers. They brought me little pellets from their nitrifying tubes, on which they had not been able to detect microscopic organisms. These, however, were full of germs. I do not believe that any special ferment, any body in the process of development (which would then have a contrary effect) causes nitrification; it is rather a physical effect of absorption and transportation of oxygen on the elements of ammonia by the innumerable germs in the earth analogous to the influence of *Mycoderma aceti* on alcoholic liquids.

should be given, for burying dead animals, to sandy or calcareous soils, in dry situations, as such soils are not favorable to the life of earth worms. The eminent Chief of Agriculture, M. Tisserand, lately told me that the carbuncular disease is unknown in the region of Savarts, in Champagne. The absence of this disease may be attributed to the fact that in the poor soils of this kind, as in the case of the Camp at Chalons, the thickness of arable land is not greater than 0·15 to 0·20 of a meter, and the subsoil is a bed of chalk in which earth worms cannot exist. In a soil of this kind, the burying of a carbunculous animal may give rise to many germs, which from the absence of earth worms will remain at a depth in the ground where they are harmless.

It would be very desirable to have careful statistics stating, in given localities, whether the carbuncular disease is prevalent or not, and also stating the nature of the soil, whether favorable or not to the presence of earth worms. M. Magne, member of the Academy of Medicine, has informed me that in the Aveyron, in localities in which the carbuncular disease is found, the soil is argillo-calcareous, while in those in which the disease is unknown the soil is schistose and granitic. I have always understood that in these latter soils earth worms do not abound.

I will take upon myself to close this communication with the assurance that, if agriculturists desire it, the carbuncular disease will soon be a thing of the past, because this disease is never spontaneous, and can only be found where it has been deposited, and where its germs have been disseminated by the innocent complicity of earth worms; and, finally, that, in any locality, it will soon disappear unless the causes of its propagation are maintained.

On the proposition of M. Thenard, the Academy decides that the paper of M. Pasteur will be sent to the Minister of Agriculture and Commerce.

REPORT ON YELLOW FEVER IN U. S. STEAMER PLYMOUTH.

Extracted from the Report of the Surgeon-General of the Navy, 1880.

IN the Hygienic and Medical Reports of the Navy Department for 1879, Surgeon Theoron Woolverton gave an account of yellow fever on board the steamship Plymouth, which not only redounded to the reporter's credit, but to that of naval surgeons as a class. It is to be regretted that the excellent opportunities enjoyed and sound sense so often displayed by our naval surgeons have been imperfectly appreciated by students of yellow fever. Case after case has been recorded and made the subject of special inquiries, with the most frequent result of demonstrating dangerous forms of naval decay and rottenness which, in tropical cruises, have combined with the essential marine factor for the development of this plague. In his statement, Surgeon Woolverton said: "It is my conviction, from the course of the disease, that the yellow fever infection is confined to the hull of the ship, and especially in the rotten wood about the berth deck." It will be remembered that the Plymouth was frozen out, but much of the badly decayed wood was left in her, notwithstanding some considerable repairs at the Boston Navy Yard, prior to sailing for the Windward Islands, last year. No sooner was the vessel subjected to tropical heat than yellow fever recurred, and the cruise had to be abandoned. Surgeon Woolverton declared that it was "not shown that cold will not destroy the yellow fever infection, but only that cold did not sufficiently or entirely penetrate the spongy wood to reach it."

With commendable solicitude, the Secretary of the Navy has pursued this case to the end, and Surgeon-General Wales has done wisely to exhaust all means of research within his reach. The monograph before us is full of interesting and suggestive matter. It shows how gradual, and yet not slow, was the deterioration in the Plymouth's sanitary condition. Launched at midsummer, 1868, and extensively repaired in 1873, she was peculiar for having an excess of white oak over live oak in her hull, and in 1877 "she began to show herself to be a decidedly unhealthy ship." In the fall of 1869 she suffered from yellow fever, notwithstanding stringent precautions against the introduction of the disease. In a report made at Hampton Roads, November 17, 1878, Surgeon Woolverton gave it as his opinion "that the fever had a purely local origin in the ship."

It was the second outbreak, on the brief cruise of 1879, after a winter's frost, that staggered naval officers and the public at large. The board over which Medical Inspector R. C. Dean presided has dispelled the mystery, while fully sustaining the mature opinion of the steamer's own surgeon. Surgeon-General Wales ordered a thorough inspection, by exposing all parts of the ship to view, and confined spaces, whence openings gave exit to a very offensive odor, were discovered. The ceiling and hanging knees, clamps etc., were extensively decayed all along the berth deck. Fungus abounded. Behind the locker on the port side was found a large quantity of partially decomposed refuse. Fœtor was unlocked, especially above "the port and bunker, and here four cases of yellow fever, all occurring during the first outbreak, were billeted. One case, occurring during the second outbreak, was billeted on the starboard side, exactly opposite, and one near the galley—localities where decayed wood was found to be particularly abundant."

Omitting various data of a like description, it is interesting to read, that "on the starboard side one of these spaces was found to be completely filled with a soft mass, of intolerably offensive odor, which seemed to consist chiefly of beans in all stages of decay; the other space was equally full of sponge, clothing, chips, and other refuse, more or less decomposed. The stench from these deposits was such as to drive the workmen on deck."

"Between other frames, on both sides, were masses of bacterial growth similar to that found in the forward shell room; and on the port side, in the *culs de sac* corresponding to those containing the beans and refuse on the starboard side, were found a quantity of unrecognizable decomposing organic matter. *It was directly above this hold that three cases of yellow fever occurred during the first outbreak.*

"Under the flooring of the magazines was a great accumulation of decomposing chips and auger dust, emitting a foul odor, and evidently left there when the ship was built. Under the lead-lining the sheathing was entirely rotten and blackened, as if the wood had been charred, and in this rotten wood dead rats and their nests were found. The thick strakes and ceiling were badly decayed. On cutting through the bread-room floors, confined air of offensive odor escaped. Living and active flies crawled out of confined spaces between the floors.

"We are of opinion," says the board, "that the various deposits of decomposing organic matter, and the quantity of decayed wood above described, are closely connected with the development of yellow fever on board of the Plymouth."

The narrative as published is most instructive, and we regret that we cannot follow the reporters in their speculations as to disinfection and the germ theory. The germ is still undiscovered, if there be any; its discovery cannot, in our opinion, upset the truth that low temperature is destructive of the yellow fever poison. That is the one incontrovertible fact in the history of the disease; but no sane man would pretend permanently to purify a foul ship like the Plymouth, without first removing all fetid accumulations and rotten wood.—*Med. and Surg. Reporter.*

FUCHSIN IN BRIGHT'S DISEASE.

IN Virchow's *Archiv*, Bd. 80, Prof. De Renzi, of Genoa, gives his experiments on Bright's disease. He arrived at the following conclusions: 1. When chronic Bright's disease is left entirely without treatment, in general no improvement is shown; hence this must be excluded from the category of those diseases which in many cases end in spontaneous recovery. In the first days after entering the hospital, or when the treatment is purposely left off, the patients show a considerable quantity of albumen; this rule has, however, some exceptions which have not up to the present time been well explained. 2. Fuchsin, which has lately been recommended in the treatment of Bright's disease, produces a remarkable diminution in the quantity of albumen. It was employed in two forms: dissolved in water, or, mixed with a suitable extract, in pills of 2½ centigrammes each. As, however, the strong coloration of the infusion of fuchsin in water is somewhat repulsive, Dr. De Renzi found it preferable to administer it in the pill form, and to this he has adhered in his latest prescriptions. 3. The daily dose of fuchsin may be much greater than that in which it has hitherto been recommended in the treatment of Bright's disease. Dr. De Renzi generally began with a very small dose of 5 centigrammes (0·75 grain), raising it to 25 centigrammes (3·8 grains), to be taken in twenty-four hours. A considerable physiological action on the principal functions of the body was observed. According to the dose of fuchsin, the urine began sooner or later to show a red color, which maintained itself throughout the treatment. 4. The urine in Bright's disease often exhibits a great deal of mucus. Fuchsin is very useful against this complication, as, in a short time, it causes the complete disappearance of the mucus from the urine. 5. The mucous membrane of the digestive track is deeply colored by fuchsin, and the blood-plasma undergoes considerable coloration. In two cases, the quantity of hæmoglobin and the chromometric state of the blood were examined with Bizzozero's instrument, with the following results: *Maria Molinari*: Cytometric state, 160; Hæmoglobin, 68·7; Chromometric state, 175. *Theresia Gabella*: Cytometric state, 115; Hæmoglobin, 29·7; Chromometric state, 112. It is evident that the increased intensity of color is not to be ascribed to the increase of hæmoglobin, but rather to the increase of the fuchsin in the blood. 6. When fuchsin does not pass into the urine, this is an indication of an organic disturbance, which must not be neglected. In these cases, it is of no use in the treatment of albuminuria. 7. Rest of the patient in bed is a very important means of diminishing the albuminuria in Bright's disease. In a patient, *Vittoria Rossi*, complete rest in bed, together with milk diet, brought about the greatest diminution of the albumen in the urine. Dr. De Renzi was several times able to ascertain that unusually active movement of the person had a dangerous effect in Bright's disease. 8. Apomorphia was in general well tolerated; and Dr. De Renzi has ordered it in larger doses than usual (viz., 5 to 6 centigrammes daily) without causing the least disturbance. In one case, this medicine considerably improved the condition of the patient.

PHOTOGRAPHY OF THE INVISIBLE.

AMID the many modifications and improvements that have taken place in the gelatine processes, we are apt to forget that, at all events in certain work, collodion is not quite put on the shelf. Among the applications of the latter is one which for the time has been lost sight of, and one which, as an aid to scientific research, no doubt, will have much to say—we allude to the process of photography by means of the invisible rays of the spectrum, which are usually called heat rays. It is now some nine months since Captain Abney gave his Bakerian lecture at the Royal Society on this subject, and, pending its publication in the Transactions of that body, the public have heard but little regarding it, though, as we can testify, the discoverer of the process has not been idle in adapting it to various uses. Among other work, we find that Captain Abney has been employing it to find out the *color* of colorless liquids. For instance, in the ordinary way of thinking, we class water, alcohol, ether, benzine, etc., among colorless bodies; but photographs of the spectrum, taken through a foot thick of these bodies, show that in some of these, certain of the invisible heat rays are entirely absent; that is, if the eye were sensitive to these dark rays, ether, for example, would have as definite a color as a solution of bichromate of potash or any other visibly colored liquid. We hope we are not anticipating the publication of the paper when we give, as another example of the utility of the research, that which relates to water, which is shown with a thickness of four feet to cut off nearly every ray which could warm animal structure. Thus, at that depth the only warmth which a fish can get is that due to the absolute warmth of the water, and not to any sunshine which might pass through the body of the water. We have merely given these as examples of what a useful application this method of photographing with these dark rays may be put to. From what we have already learnt of this subject from papers communicated to the Photographic Society and elsewhere, it appears that Captain Abney employs a species of silver bromide which, when viewed by transmitted light, is of a peculiar blue tint, a tint, by the way, which seems to be different to that which is so common in the gelatine processes; and it appears from what we have learnt from him that gelatine is not a hopeful vehicle in which to obtain this peculiar modification of the silver bromide. In the first place, it seems that it is necessary to employ an excess of silver in its preparation, and also a large excess of acid, both of which would appear to be fatal to its formation in gelatine. Again, another remarkable point is that the slightest pressure is able to reduce this blue bromide of silver to a condition of insensitiveness, the pressure of dried gelatine being sufficient to do so. In one experiment Captain Abney transferred the bromide from collodion to gelatine, and prepared plates with it, expecting to find the sensitiveness intact; but the fact of the transfer rendered it slow, and totally insensitive to any rays except those ordinarily useful for photographers. The peculiarity of this especial preparation is that, instead of having one part of maximum sensitiveness to the spectrum, it has two—one in the blue, as is the case with the ordinary preparation of the bromide, and the other just outside and below the red, and it is this part, of course, which enables photographs of the invisible radiations to be impressed. When Dr. Vogel showed that what is called non-actinic but visible light could be rendered actinic by means of the addition of certian dyes, he made a great step forward in the direction to which we have been referring, and, no doubt, as Captain Abney was good enough to point out to us, if a dye could be found which absolutely absorbed the invisible heat rays, any ordinary emulsion could be used for the same end merely by dyeing the film; but, unfortunately, all the dyes which are impressionable by light—or, as Dr. Vogel calls them, which are optical sensitizers—transmit nearly all of the heat rays, and are not, therefore, affected by them. Be that as it may, the whole of the rays of light, visible and invisible, have been proved capable of impressing a photographic image, and it now remains for photographers to utilize them in the most effective way they can. It is something even now to know that a kettle of boiling mercury can be photographed in an absolutely dark room by the radiations which it emits, and it seems in the bounds of probability that the radiations from a human body may suffice to give an impression on a sensitive plate under similar circumstances.

It is to be hoped that the publication of the Transactions of the Royal Society will not be long delayed, so that every one interested in this kind of research may have the full benefit of what has already been done.—*Photographic News.*

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